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Walter V. Bingham

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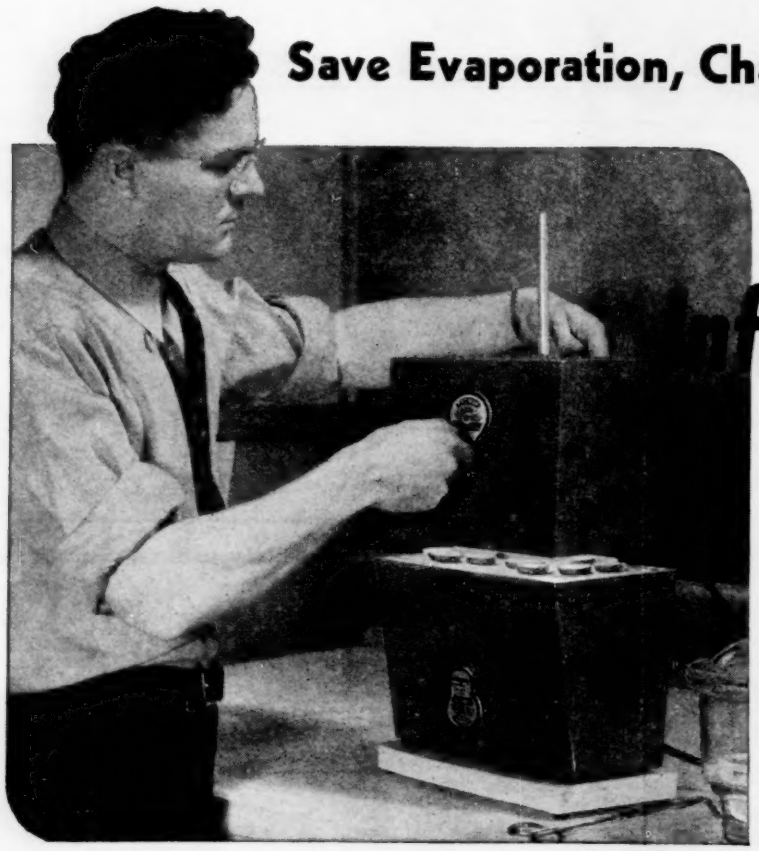

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Vol. 104, No. 2694 Friday, 16 August 1946

Inequalities in Adult Capacity—From Military Data

Walter V. Bingham

Chief Psychologist, The Adjutant General's Office, War Department

TEN MILLION MEN HAVE TAKEN the Army General Classification Test. This is the most widely used of many tests of ability, aptitudes, trade proficiency, and technical knowledge developed by the Army as aids in classifying its personnel. During tense years of rapid mobilization and campaigning, this test has served a specific military purpose, namely, to indicate the rate at which each individual soldier might be expected to absorb training and the level of difficulty of the material he should be capable of mastering.

After describing this classification test and the inequalities of adult capacity which it measures, the frequencies of occurrence of these differences will be brought into relationship with certain other variables, educational and occupational. These data throw light not only on military problems; they illuminate also our conception of the American people, reminding us of our failure to conserve and capitalize to the full our national endowment of human resources.

The AGCT

The Army General Classification Test—AGCT for short—is not an IQ Test, if the words "Intelligence Quotient" are correctly used. An IQ is a ratio. It expresses the *rate* at which a child's mentality has developed. The ratio of his attained level of intelligence to his age is called his intelligence quotient. During infancy, childhood, and early youth this quotient not only tells the rate of development which has already taken place but also indicates in a general way, although not very precisely in individual cases, the probable rate of subsequent development and the level likely to be reached at maturity.

When a recruit joins up, it is not difficult to ascertain how intelligent he is; but it is too late to ascertain his intelligence *quotient,* because the information is not available as to whether he had reached his mental maturity at age 18, 17, 16, 15, or 14. This is one reason why the Adjutant General's Office in 1941 emphasized the inappropriateness of expressing adult capacity in IQ terms (*1*). Another reason, essentially practical, is that a personnel classification officer is not interested in knowing what a soldier's rate of development *has been.* Instead, the question is: How intelligent is he now? What can he learn and how fast can he learn it?

Neither is it a matter of practical concern to know what a soldier's *native* intelligence was at birth, before his mental development had been facilitated in any degree by stimulating surroundings or hampered by a stultifying environment. The assignment officer wants an index of what the new soldier can be expected to learn, rather than a figure which purports to tell what he might have been able to learn if only he had had a better home, no enfeebling illness, and a great deal more education.

What a soldier can learn to do is a reflection not only of his original endowment. It is conditioned also by what he learned while growing up—the mental furniture he accumulated. His adult capacity to learn the complicated arts of war is determined in part by the educational opportunities he has had and the way in which he has grasped those opportunities, and only in part by the native capacity with which he was born. It is not our intention to attempt the baffling task of disentangling the interwoven threads of heredity and environment; of family stock, ancestry, and race; of age, schooling, and experience; and of motivation as a contributor to achievement. Those are puzzles for the geneticist and the sociologist; but the facts reported here may furnish some grist for their mills.

The AGCT exists in several forms. Four alternate forms, known as 1a, 1b, 1c, and 1d, have been used in examining troops who are literate in the sense that they can read English. Two forms in Spanish are used in the Caribbean Command. A nonverbal test, known as 2abc, was developed for use with illiterates and troops literate only in some language other than English, such as Chinese. This can be given in pantomime, without spoken directions. A relatively new

Presented at the annual meeting of the National Academy of Sciences, 22 April 1946.

and longer examination, known as Form 3a, currently taken by all recruits and inductees at Reception Centers soon after they have been accepted and sworn into military service, yields in addition to the general classification score a profile of four other useful scores.

Forms H–1 and H–2, focused on the higher levels of ability, were designed for use in screening applicants for training in Officer Candidate Schools, while R–1 and R–2, more discriminating in the lower part of the scale, have been used in Recruiting and Induction Stations to identify the least promising applicants for enlistment. Mention should be made also of the Army Individual Test, an instrument of wide applicability where conditions call for a careful recheck of a soldier's standing.

Most of the data here presented were secured with one of the four forms first mentioned. Each of these poses three kinds of tasks: verbal, arithmetical, and spatial. The verbal items, increasing in difficulty, sample a person's grasp of precise meanings. The arithmetical items require numerical computation and solution of problems smoothly graded in difficulty from easy to hard. The spatial items test ability to visualize and to think about the relationships of things in space. All items are of the multiple-choice sort, requiring no writing of answers but only the selective marking of answer sheets which can then be evaluated objectively, accurately, and rapidly with an ordinary scoring stencil or with an electrical test-scoring machine. The time allowance, following a preliminary period of instruction and fore-exercise to make certain that the directions are understood, is 40 minutes, which is long enough for most men to reach their upper limit of difficulty. The reliability of these forms lies between .94 and .96, as estimated by the conservative Kuder-Richardson formula (*4*).

The Standard-Score Scale

Scores are expressed in terms of a standard scale on which 100 represents the midpoint of the distribution and 20 is the standard deviation (the root-mean-square deviation) from this central tendency. The extreme range of standard scores is from 39 to 163. The middle zone, called Army Grade III, includes all scores from 90 up to but not including 110—that is, within the range ±0.5 standard deviation from the mean. The next higher zone, called Army Grade II, extends from 110 to 130. All scores of 130 or higher are in Army Grade I. Similarly, below the middle zone are Army Grades IV and V[1] as seen in Fig. 1.

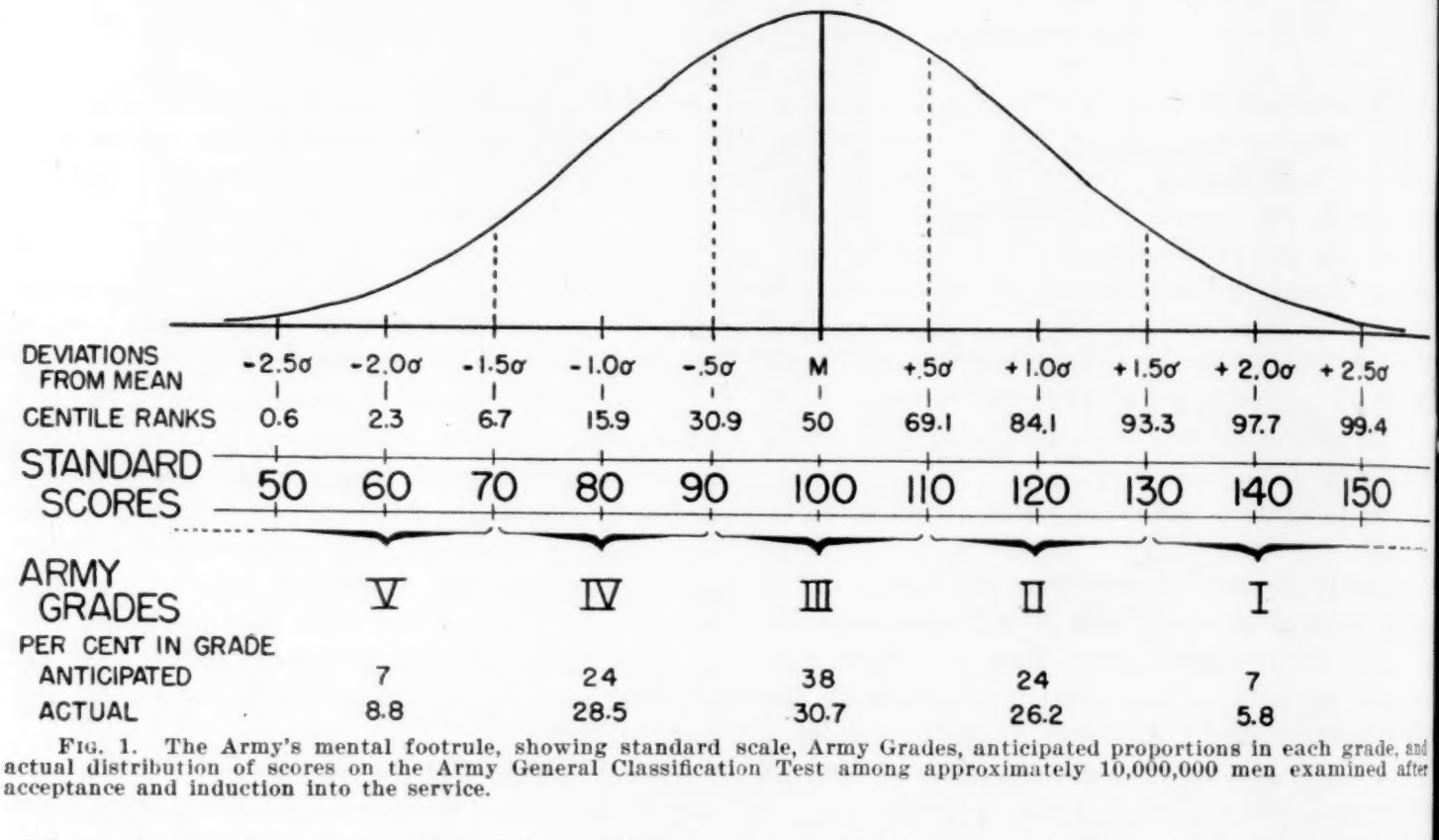

FIG. 1. The Army's mental footrule, showing standard scale, Army Grades, anticipated proportions in each grade, and actual distribution of scores on the Army General Classification Test among approximately 10,000,000 men examined after acceptance and induction into the service.

On a scale so defined, a normal distribution of scores would have been bell-shaped, symmetrical with respect to the midpoint, as follows: in Grade V, the lowest, 7 per cent of the population; in Grade IV, 24 per cent; in Grade III, 38 per cent; in Grade II, 24 per cent; and in Grade I, 7 per cent. The actual distribution was somewhat flattened and skewed by peculiarities of population sampling, such as those introduced by policies of Selective Service regarding deferments. Then, too, the original scaling and calibration of the

[1] The dividing point between Grades IV and V, originally set at standard score 70, was changed in 1943 to 60, for administrative reasons.

test in 1940 had been accomplished during the earliest stage of mobilization, under pressure for haste, with data from less than 3,000 subjects, a sample neither large enough nor sufficiently representative of the total population, rural and urban, East and West, North and South. In this sample were too few of the very stupid and the very brilliant, of the wholly uneducated and the highly educated. Under the circumstances it is not surprising that the anticipated distribution of scores has been approximated only roughly. The proportions found are: in Grade V, 8.8 per cent; IV, 28.5 per cent; III, 30.7 per cent; II, 26.2 per cent; and I, 5.8 per cent.

The Population Sample

The population of approximately 10,000,000 on whose performance these actual proportions are computed includes all enlisted men taken into the Army during a five-year period beginning on 1 March 1941. This is an enormous sample, but it differs from the entire national population of the same age and sex in important ways. All who took this test had met minimum standards for acceptance into the military service. The physically or mentally disqualified had already been screened out. Missing, too, are those registrants who were not called for training because of dependents, civilian occupation, or other reason; while only those officers are represented in the tabulation who had first served as enlisted men and earned their commissions in Officer Candidate Schools or, in a few instances, on the battlefield. To be sure, graduates of schools for training officer candidates, warrant officers, and aviation cadets constituted more than 8 per cent of the officer population. Of the remaining 32 per cent (the officers who did not take the AGCT), three-fifths were National Guard, Reserve, and Regular Army Officers and the remainder were doctors, dentists, chaplains, and other specialists commissioned in the Army of the United States directly from civil life. It is not unwarranted to assume that if all these officers had been included in the population tested, the proportion scoring in the top bracket would have been a little larger, the curve of distribution less skewed to the right.

The proportion of the Army population in each of the Army grades varied considerably from one year to another. Changes in minimum standards of acceptability had their effect, as did nationwide policies regarding deferments and to some extent, perhaps, the attitudes of local boards.

In 1940 and until 17 April 1941 every recruit inducted within the continental limits was supposed to be able to understand simple orders in English and to read and write in English or in some other language; but Army regulations did not prescribe very precisely the required degree of literacy or the procedures by which it was to be ascertained. During this period, however, it was established that soldiers in training who could not read English about as well as the average man who had completed four years of school were having so much difficulty in learning that they were holding up the progress of their units; so a half-dozen simple paper-and-pencil tests were developed and standardized for use at Recruiting and Induction Stations whenever the interviewers were in doubt as to a man's ability to read at what came to be called the fourth-grade level.

During 1942 available man power became less abundant. In particular, draft boards in certain communities where the population was largely colored found it hard to meet their quotas of literate inductees. So, beginning on 1 August, acceptance of a certain proportion of illiterates was permitted. The rule was that on each day not more than 10 per cent of the white men and 10 per cent of the colored men processed at an Induction Station might be illiterate provided they were physically fit and were able to pass a specified nonverbal mental test. These regulations remained in effect until 1 February 1943, when the maximum proportion of illiterates was cut to 5 per cent of each day's intake. Then, after 1 June 1943 illiteracy as such was no longer a bar to induction. Examiners at Recruiting and Induction Stations were furnished a new set of screens—a battery of tests designed to admit to military training all bright and physically fit men even though they did not know how to read, while excluding the very dull even though they were literate. At the same time the 93 Induction Stations were provided with qualified examiners familiar with the new techniques, 140 psychologists having been commissioned and trained in the Army's procedures of examining. After further experience and experimentation a revised battery of induction station tests was introduced in June 1944, and these standards and procedures prevailed until after V-J Day when, on 23 September 1945, the induction of illiterates was discontinued. These changes had their inevitable effect on the proportions of men in the service scoring in the different Army grades.

Parallel with alterations of minimum standards the Army introduced significant changes in the organization of training. At first the assimilation of Mexicans, American Indians, Chinese, Puerto Ricans, and others who knew little or no English even though educated in their own language had posed a serious problem in the training centers. To meet this situation Special Training Units were established where unique procedures were developed for teaching such men rapidly. These units provided 12 weeks of well-conceived and effectively supervised instruction in reading, language

expression, arithmetic, and the most elementary military subject matter. Progress was astonishing. With such a head start, most of these men were then able to pick up the ordinary routines of basic training and carry on. So, in June 1943, Special Training Units of this sort were established in each Reception Center. Here, immediately on acceptance into the service, were concentrated the illiterates, the non-English-speaking literates, and all who scored in Army Grade V on the AGCT. After 12 to 16 weeks of this introductory training nearly 85 per cent of this otherwise unusable personnel was salvaged. Many whose test performance at entrance was in Army Grade V were able to raise their standing to Army Grade IV or even higher. Such are some of the facts that account for the changes observed from year to year in the distribution of AGCT scores.

Validity

The AGCT is valid in the military situation. It tells, at least approximately and in a usable way, what it purports to tell about a man's capacity to learn. For example, in the training camps it was found that the population scoring in the upper ranges of the test, namely, in Army Grades I and II, furnished a large majority of the pace-setters and of those who were able to master the more advanced military specialties. More than half of the men scoring in these grades became skilled technicians, noncommissioned officers, or specialists; and practically all of the hundreds of thousands of enlisted men who eventually went to Officer Candidate Schools and earned commissions were drawn from this upper range. There were exceptions. For example, although a standard score of at least 110 was ordinarily prerequisite for assignment to an Officer Candidate School, a War Department regulation permitted enlisted men to attend if they had had two years of Junior ROTC training. Thirty-five such soldiers taking officer candidate training at Fort Benning were found to have scored below 110 on the AGCT, and of these, three passed the course and received their commissions. The other 32 failed. Instances also occurred in which commands were required to fill quotas of Officer Candidate School candidates even though they did not have men enough who could meet the specifications. Most of these failed the course, either for poor scholarship or lack of leadership.

The middle zone, Army Grade III, furnished a substantial number of corporals, sergeants, clerks, and technicians and a great many capable privates.

In Army Grade IV also were large numbers of men who absorbed basic training thoroughly in the short time available and then could be relied upon to exhibit the resourcefulness and skills which warfare now demands of every individual fighter in the ranks. Some in this grade became noncoms and specialists, and at the other extreme some qualified only as unskilled laborers.

Of those who scored in Army Grade V, about one-third demonstrated capacity to learn the art of combat. For the others there were many kinds of useful work in training camps, ports of embarkation, and transport services, but some of the men proved to be more of a burden than a help during mobilization.

On each soldier's Qualification Card were entered the essential data about his age, physique, occupational experience, schooling, hobbies and sports, familiarity with foreign languages, previous military experience, if any, and his score in the AGCT. Here, too, were recorded his standing in any special trade tests, aptitude tests, or achievement tests the Army examiners found it expedient and feasible to use as supplements to the data obtained by interview. Such personal data were invaluable when selecting men for unusual duties or for training in a military specialty (*2*).

The utility of these data was most vividly in evidence whenever a new division was being activated and an arriving trainload of novices or partly trained troops had to be distributed quickly to the various regiments, companies, batteries, and service units in such a way that each unit would have its due proportion of the available skills and abilities.

AGCT data helped in selecting the men who were to take special training (*4*). Three examples illustrate the degree of validity of predictions from such scores. Among 1,042 men in training as weather observers, to cite one instance, it was found that the chances that a soldier would do average or better in the course were only 3 in 100 if his AGCT standard score was 80; 12 in 100 if his standard score was 100; 35 in 100 if his standard score was 120; and 65 in 100 if his standard score was 140.

The chances in 100 that a man receiving a certain standard score in the AGCT will achieve average or better in a course of training for general clerical work were ascertained to be as follows: 1, if his score is 60; 5, if it is 80; 20, if it is 100; 47, if it is 120; and 76, if it is 140.

These findings surprise no one. Less generally recognized is the validity of such a test as a predictor of average or better success in learning to be an airplane and engine mechanic:

Standard score—60	80	100	120	140
Chances in 100— 5	17	40	67	85

This prediction is almost as good as that from a paper-and-pencil test of mechanical aptitude given the same soldier-learners. But neither of these tests came up to the validity, for this purpose, of a Test

nical Trade Test consisting of the best items from a general technical test and a trade information test. Most striking was the relative futility, in this situation, of all the many performance tests of manual dexterity, mechanical ingenuity, and manipulative skill that were proposed and tried. What has to be acquired in this as in most other difficult mechanical trades is the know-how, the ability to diagnose what is wrong, good judgment in selecting the right tool, and knowledge of how, when, and where to apply it. These indispensable qualifications do not reside in an artisan's hands but in his head. Dexterity, motor control, and manual proficiency are of distinctly secondary importance in mechanical occupations such as this one.

In situations like these the AGCT demonstrated its validity, within reasonable limits, as an indicator of ability to learn a soldier's duties. The inequalities of capacity which it roughly measures range all the way from an intelligence level characteristic of able officers and technicians to the minimal mental equipment required for performing the most simple useful service in the military establishment. This range is wide.

Relation of Test Score to Schooling

The individual differences revealed by this Army test are related positively but not very closely to differences in education and in occupational level. The higher a soldier's educational level, the greater is likelihood of scoring in Army Grades I or II. But note: vast numbers of the men in these top zones of intelligence never went beyond high school. Among those who did not even finish grammar school were about 5,000—.0005 per cent of the total population examined—who scored in Army Grade I.

Most of the soldiers who had graduated from a college scored in Army Grades I or II. Indeed, their average score was close to 130, at the dividing point between Grades I and II. So far as intellectual capacity is concerned it is not unreasonable to assume that nearly all young men in Army Grade I, at least, would be pretty good risks for college and for professional training provided they had had a chance to finish their secondary schooling. Yet, of all the soldiers in Army Grade I, only one-fourth are college graduates.

In Army Grade II the approximate distribution by educational level is as follows: 184,000 are college graduates; 1,666,000 finished high school but not college; 858,000 completed eighth grade but not high school; and 56,000 did not complete eighth grade.

Altogether in Army Grades I and II there were about 2,000,000 men who had finished high school but were not college graduates. This is one-fifth of the entire population examined. Here is a vast acreage of human capacity. Has it been cultivated as intensively as it should?

Some of these men actually may have obtained a better education off campus than they would have obtained in a college and gone farther up the ladder of subsequent achievement. However, the question that remains is: Are there not several hundred thousand who had the requisite capabilities but did not accomplish what they might have, in peace and in war, because their education was truncated?

Test Score and Occupation

The fact of America's prodigality with her human resources comes into focus again when we examine the distribution of AGCT scores in each of several fields of occupation.

Looking at the average test performance within each occupational group, it is obvious that the occupations arrange themselves in a sort of hierarchy. At or near the top are the learned professions and such occupations as chemist, accountant, auditor, and business manager; while laborer and farmhand are close to the other extreme. This is what anyone would expect. The great variability or spread of scores within each occupation is not as commonly appreciated nor is the amount of overlap when any two occupations are compared. In one study, for instance, of the men whose civilian occupation was driving a heavy truck, the upper one-fourth outranked in test score the lower one-fourth of the managers and officials. Among the professions the law ranked close to the top; but 9 per cent of the boilermakers did as well as the average lawyer.

So it is with several hundred callings which furnished man power to the Army. In a majority of them were men who, given the will and the opportunity, might have prepared themselves to follow successfully an occupation or profession more valued than the one they chose or into which they drifted or were forced by circumstance.

Of immediate concern to the National Academy of Sciences is the current shortage of young scientists. The supply of physicists, mathematicians, biochemists, psychologists, and specialists in other branches of natural science is distressingly insufficient. Most conspicuous is the deficit of scientists capable of filling top positions in research and in university departmental administration. Similar shortages are evident in such applied sciences as electronics, mechanical engineering, pharmacology, and scientific agriculture. These occupations compete for talent with other areas of specialization: with the social sciences and the humanities; with the fields of literature, history, art, education, social work, politics, public administration, and business management; as well as with the tradi-

tionally learned professions of law, medicine, and the ministry. In a confused and shaken world, the national defense also must absorb a larger fraction of the country's brains than were concentrated in the military profession during the 1920's and 1930's.

For these reasons America must no longer be prodigal of the capacities of her more promising youth.

Conclusion

We have seen that the AGCT measures a wide range of inequalities in adult capacity. With this yardstick, data have been collected from a massive population for a practical military purpose. These data, when brought into relation with facts about schooling and civilian occupation, reveal a vast pool of talent now only partly drawn upon. Large numbers of men have been identified whose levels of accomplishment, in both education and vocation, have fallen short of their potentialities.

These facts are a challenge to conserve the national heritage. This consists not only of fertile soil, mineral wealth, oil, water power, forests, and wildlife, but also of that most precious of resources, the intellectual capacities of our young people. Does it not follow that the number of scholarships available to really superior applicants for higher education should be greatly increased? Gates of opportunity in colleges, technical institutions, and graduate schools should be opened more widely or—wherever such facilities are overcrowded—more discriminatingly. To select the most promising from among multitudes is no longer a baffling task. It has been done. It can be done widely.

Experience of the military services during mobilization and war dictates an expansion of civilian facilities for intervewing, testing, record keeping, and counseling of young men and women. Staffs of qualified specialists such as those a few universities now maintain should be available in every educational institution to identify the most promising students and to facilitate their advancement. Incentives must be widely and plentifully supplied, and new ambitions stirred in any and all who aim at vocational targets less worthy than the best of which they are capable.

References

1. Bingham, W. V., *et al.* *Science*, 1941, **93**, 572–574.
2. Bingham, W. V. *Ann. Amer. Acad. polit. soc. Sci.*, 194 **219**, 18–28.
3. Bingham, W. V. *Science*, 1944, **100**, 275–280.
4. Staff, Personnel Research Section, Adjutant General's Office. *Psychol. Bull.*, 1945, **42**, 760–768.
5. ———. *Personnel classification tests.* (War Dep Technical Manual TM 12–260, rev.) Washington, C.: U. S. Government Printing Office, April 1946.

Obituary

Frank Michler Chapman
1864-1945

Frank Michler Chapman was born in Englewood, New Jersey, on 12 June 1864. Following graduation from the Englewood Academy in 1880 he entered the banking profession as an employee of the American Exchange National Bank of New York City, but his growing interest in birds impelled him to resign in 1886 in order to devote his life to ornithology.

He spent a little over a year as an independent student, during part of which he worked as a volunteer assistant to J. A. Allen, then head of the Department of Mammals and Birds in the American Museum of Natural History. Shortly afterward, he was offered a permanent position in the Museum and on 1 March 1888 began his official duties as assistant in Dr. Allen's Department. He was made assistant curator the same year, associate curator in 1901, and curator in charge of birds in 1908, and, when the Department of Birds was formally separated in 1920, he was appointed its first curator, a position which he held until his retirement in 1942.

The intervening years were busy ones. Chapman's principal interests were always concerned with reaching the public, and the exhibition halls of the Museum gave him wide opportunity to achieve this end. He gave his early attention to the possibilities of the "habitat group," and his first experimental display of the bird life of Cobb's Island, Virginia, proved so successful that he devoted a large part of the following decade to the collection of material for a large series of comparable groups of the birds of other parts of North America. These were followed, in turn, by more elaborate exhibitions of birds of the world, the domes of flying birds surmounting certain other halls, and still other displays.

His pen, meanwhile, was likewise busy. In 189 he obtained the cooperation of the Audubon Society and commenced the publication of the popular magazine, *Bird-Lore,* which he continued to edit through 1934, when it was taken over by the Society. Throug

the medium of this journal and the lecture platform he reached a widespread public that found in him an inspiration for its growing interest in birds, and his influence as a great popularizer of bird study was unexcelled.

During this period, also, he published numerous books that proved of great value and interest to the widening circle of bird lovers. Among these may be mentioned his famous *Handbook of birds of Eastern North America* (1895 and subsequent editions); *Bird life* (1897); *Bird studies with a camera* (1900); *Color key to North American birds* (1903); *The warblers of North America* (1907); and *Camps and cruises of an ornithologist* (1908).

In his more technical studies Dr. Chapman was interested particularly in the ornithology of Latin America. He published numerous taxonomic revisions and descriptions of many new forms from this region, but his emphasis was on the larger topics of the origin and distribution of the forms concerned. His monumental books on the distribution of bird life in Colombia (1917) and in Ecuador (1926) developed this thesis extensively and have formed the basis of much subsequent work of similar nature.

In the course of his investigations Dr. Chapman visited many parts of Latin America and gained a firsthand acquaintance with the regions whose avifaunas were the subjects of his study. In later years he took advantage of the facilities offered by the tropical research station on Barro Colorado Island, Canal Zone, and spent his winters there in field studies of the local birds and other aspects of nature. Two books, *My tropical air castle* (1929) and *Life in an air castle* (1938), are filled with interesting observations made during his sojourns in this retreat. In 1933 appeared his *Autobiography of a bird lover*, in which the many facets of his abundant life are recounted, in interesting detail.

He retired from active museum life on 1 July 1942 and thereafter made his home in Florida, where he was able to continue his outdoor observations throughout the seasons. While in the North on a summer visit in 1945, he became seriously ill and died in St. Luke's Hospital, New York City, on 15 November.

For his scientific attainments, Chapman was given the degree of Doctor of Science from Brown University in 1913. He was affiliated with many scientific societies and was an honorary member of a number of them. He was the recipient of the Brewster, John Burroughs, Elliot, Linnaean Society (New York), and Roosevelt medals.

His career was broad and his attainments noteworthy. No history of the development of bird study in America can ever be complete without a prominent place being accorded to Frank M. Chapman, who, more than any other individual of his time, helped awaken public interest in his feathered friends.

JOHN T. ZIMMER

The American Museum of Natural History
New York City

Association Affairs

The Subsection on Pharmacy of Section N is planning to renew its meetings, beginning with the December meeting of the Association, on a more extended basis than ever before. Assurance has been received that sufficient hotel accommodations will be available to house all out-of-town guests. Because the total program for the Association is very extensive, it is necessary that the program material be submitted by 21 October 1946. Glenn L. Jenkins, secretary of the Subsection, has issued a call for papers in the fields of pharmacy, pharmaceutical chemistry, pharmacology, or pharmacognosy, requesting that the titles of papers be submitted at this time and the abstracts and copies of the papers at a later date. The titles should be sent to J. L. Powers, chairman of the Subsection.

Reservations for technical exhibit space at the Annual Science Exhibition, to be held in connection with the 113th AAAS Meeting, Boston, 26–31 December 1946 are now being accepted. Through special arrangements the Association will be able to house both technical and scientific exhibits in the First Corps Cadet Armory which is across the street from the Hotel Statler, headquarters hotel for the meeting (*Science*, 1946, **104**, 98). Advance requests for technical exhibit space indicate that manufacturers are arranging to demonstrate their latest products and items which will be available soon.

For details about available space, costs, etc., address: Theo. J. Christensen, Exhibition Director, AAAS, Massachusetts and Nebraska Avenues, NW, Washington 16, D. C.

Technical Papers

Observations of Behavioral Development in the Loggerhead Turtle (*Caretta caretta*)

KARL U. SMITH
University of Wisconsin, Madison
and
ROBERT S. DANIEL
University of Missouri, Columbia

The embryonic development of response in the loggerhead turtle (*Caretta caretta*) has specific implications for the problem of maturation of integrated behavior. The trunk of the loggerhead is housed in a shell which prevents the participation of gross trunk activity and mass-type movements in the adjustive behavior of the animal. The initial reactions of the animal in the egg stage of development, before the development of a body shell, have therefore been of spcial interest. In addition, a general survey has been made of the maturation of various reactions which are performed by the turtle in the course of embryonic development.

OBSERVATIONS

Nesting, fetal behavior development, and neonate activity of the loggerhead were observed in animals procured along the eastern coast of Florida. The female turtle deposits the eggs in the sand of the beaches in this area from late May to early August. Nests were located the morning after installation and marked for ease of relocation. Sample eggs were removed from the nests at specified later dates and taken to nearby quarters set up for observations. Eight nests were used in the study, from which 55 fertilized eggs were removed for observation. This sample represents about 5 per cent of the total number of eggs in the eight nests.

The female comes on the beach at high tide during the night. Leaving an unmistakable furrow and flipper path, she climbs above the high-tide level, excavates a hole about 24 inches deep with scooping movements of her rear flippers, and deposits a large number of eggs in the cavity (usually 75 to 150). After covering the eggs she partly camouflages the area by random movements and haphazard disturbance of sand, after which she returns to the sea. The incubation period of the eggs is 45–50 days in this locality. After hatching, the young turtles remain in the nest for several days, the exact time depending upon their mode of escape. They may emerge from tunnels dug by raiding sand crabs or by exits of their own making, effected by a slow milling about until the floor level of the nest is brought to the beach surface. Escape occurs at night or during the early morning hours.

In order to stimulate and observe the animals in the fetal stages, an opening was made in the eggshell after the turtle's position was determined and oriented for the operation. In the early stages the membranes supporting the fetus were not disturbed. Stimulation was effected by means of hair aesthesiometers mounted on rods. Specific areas were marked for stimulation and a standard procedure used in application of the hair

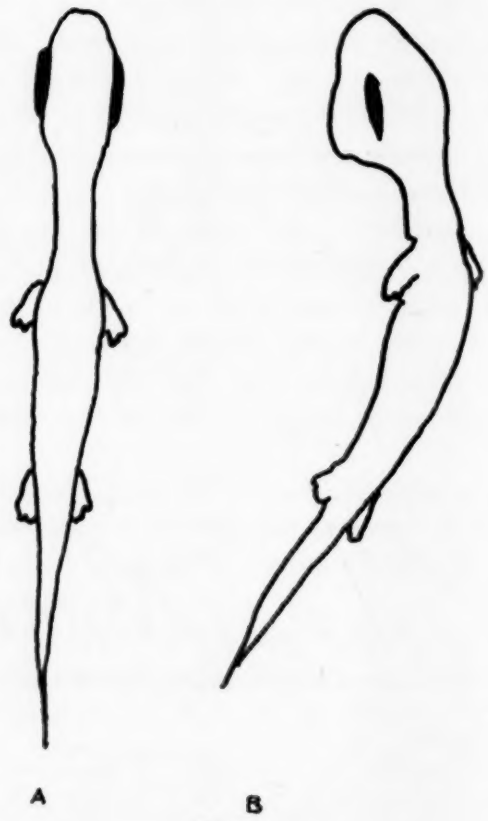

FIG. 1

stimulator. In making the observations the eggs were supported and their temperature maintained near that of the nest (86° F.).

The general results of the observed development may be summarized as follows:

Mass movement. Behavior responses of a spontaneous nature as well as stimulus-elicited reactions occur in the turtle fetus prior to the formation of a shell, which is evident at approximately 20 days. The earliest responses are seen at the 12th to the 14th day of egg life. These initial responses do not seem to involve limb reactions or specific responses of any sort, but are invariably a C-type twisting reaction of the

entire body, which during that period has a relatively elongated (1–2 cm.), thin structure (Fig. 1a). This C-movement consists of a flexion of the body in its horizontal plane, head and tail areas moving toward each other, and a simultaneous twisting of the head in the same direction as the body flexion (Fig. 1b). The movement may involve twists to the right and return, to the left and return, or alternations of the two. Up to 12 or 15 individual twists were sometimes observed following a single stimulation or (apparently) spontaneous initiation of activity.

Early differentiation. Limb reactions occur clearly for the first time at the 18th to the 21st day of development. Even then, local responses are rarely, if ever, seen as independent of the still-occurring and more general C-response. These limb twitches follow immediately after, and are a part of, the C-response and may be most easily observed by stimulation of the limb itself. The C-response can still be elicited from any part of the animal, including the shell, but it is obtained more readily by application of the stimulator to the neck, eye region, and base of the fore flippers.

Specific responses. Beginning at about 22 days. specific responses of the eyelids, mouth, and head can be elicited by direct stimulation of those parts. A day or so later the limbs show a similar type of response, and the tail responds at 32 days. During this period the shell has become semirigid and insensitive to the stimulator. C-reactions and other gross movements drop out of the picture, but stimulations on one side of the animal give movements toward the stimulus locus as a rule, in a manner reminiscent of the true C-response.

Complex fetal behavior. Appearing first between the 26th and the 32nd days are several activities closely associated with behavior in the later normal sea environment. In the order of their appearance were found coordinated swimming movements, stimulus-directed activity (protective and avoidance), snapping, nystagmic head response to rotation, righting reactions, crawling, and finally, tropistic orientation toward the ocean.

Neonate behavior. Within a few hours subsequent to hatching the young loggerhead performs most of the basic reactions essential to continuance of life in an environment typical for this animal. Especially noteworthy are the abilities to escape from the deep nest, direct visual orientation toward and escape into the ocean, orientation in the sea toward deep water, and the abrupt occurrence of eating a few days after hatching. A series of observations indicated clearly that the ocean approach behavior is largely, if not entirely, a positive phototropism.

The first three patterns of conduct just noted occur when the animal is prematurely released from the egg. Within the intact egg the fetus is, of course, gradually filling the cavity so that movements are more and more restricted. At the age when complex fetal behavior was found to occur in the exposed egg, there is insufficient space available to the turtle in the intact egg to permit movements of the magnitude necessary for practicing the act. This is especially true of the front flippers, which are folded over the shell in the manner shown in Fig. 2. Notwithstanding this con-

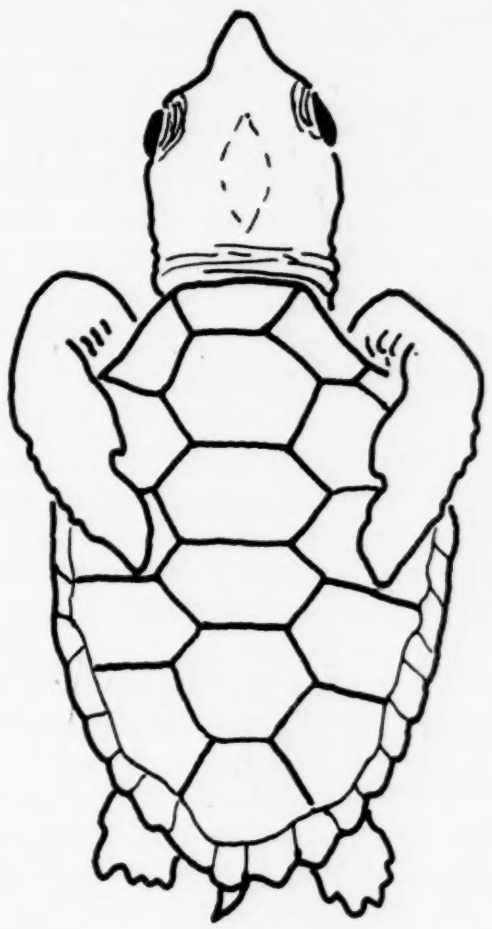

FIG. 2

dition of restraint of the flippers during the later stages of development, these members are perfectly integrated in the total adjustment of the animal in swimming, crawling, righting, and avoidance reactions as soon as the animal is released from the shell either 8–12 days prematurely or at term. It would appear that in the loggerhead response repetition in embryo may be ruled out as a factor in the formation of integrated movements of the front flippers especially. These observations agree with the principal finding of this study, that the initial development of behavior in the loggerhead proceeds in terms of specialization of local responses within an evolving matrix of mass movements, which constitute basic behavioral patterns for the maintenance of integration of developing local movements.

A more detailed report of the present experiments and observations will be given elsewhere.

Conclusions

The behavioral development of the loggerhead turtle in the egg consists of an initial mass-type C-movement, the appearance of local response integrated with this pattern, and finally, elaborations of patterns of behavior subsequently adjustive in the terrestrial and aquatic environment of the animal.

The occurrence of a mass C-movement as a primary functional pattern of behavior is especially significant, since it establishes more firmly the role of mass movement in the development of response. The observations show that these initial, generalized movements occur in an animal which, within a very short time, is incapable of displaying mass trunk activity.

Observations show that behavioral maturation and integration in the turtle are not related to embryonic practice or repetition of response, but rather that they appear to occur as an outcome of physiological differentiation and specialization of more generalized movements in the maturation process.

Very generally, results indicate that in the growing loggerhead the specific local movements as well as adaptive coordinations of response are ontogenetically organized with reference to more primary and generalized patterns of behavior which constitute a matrix for subsequent evolution of response.

The Concentration of ^{39}K and ^{41}K by Balanced Ion Migration in a Counterflowing Electrolyte[1]

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It has long been suspected that isotopic ions in solution might differ in their migration velocities (*3*). The negative results obtained by Kendall (*2*) in the electrolysis of Li^+ and Cl^- ions through agar-agar dispelled most of the hope for an isotope effect of this type. Recently, however, a counter-current ion transport method has been developed which not only establishes the reality of this effect but also makes possible the continuous concentration of both $^{39}K^+$ and $^{41}K^+$ isotopes.

The basic principle of operation of the method rests in an imposed flow of electrolyte through the cell at a rate sufficient to reduce the net transport of K^+ ions to zero. Under this condition the faster-moving $^{39}K^+$ ions will make headway against the electrolyte stream toward the cathode compartment, while the slower-moving $^{41}K^+$ ions will be carried back toward the anode compartment.

Tiselius (*4*) has described a method based on a mass flow, which he designated as a "compensation movement" for the separation of proteins by electrophoretic migration. The separation takes place between a series of boundaries set up by the various proteins and is conducted at 4° C. to minimize convection currents in the solution. The experimental arrangement of Tiselius cannot be utilized for the concentration of isotopes, however, since the difference in mobility of the ions is small compared to the processes giving rise to remixing.

In the separation of electrolytic ions, where the transport can be looked upon as a small forward drift superimposed on kinetic agitation, it is necessary to reduce the rate of remixing in the electrolyte to a point below the rate of separation. Also, to obtain appreciable concentrations a multiple-stage process must be employed. Both these requirements have been met in the present experiments by carrying on the electrolysis in a fine-grained packing of uniform porosity. The packing not only reduces remixing to a minimum but acts as a fractionation column operating under total reflux. Packings have been made of sand, glass wool, cotton, glass beads, etc.

During the initial stage of the operation, the molar isotope transport equals the gain in concentration of the faster-moving isotope in the cathode compartment and is given by

$$\frac{I^+ \times t \times (\varepsilon - 1)\ N_1N_2}{F} = \frac{V_c \times C}{1000} \cdot \frac{R_t - R_o}{(R_t + 1)\ (R_o + 1)} \text{ moles } ^{39}K \qquad (1)$$

where I^+ = positive ion current before superimposing the counterflow, in amperes; t = time in seconds; N_1, N_2 = mole fractions of ^{39}K and ^{41}K, respectively; R = isotope abundance ratio, N_1/N_2; V_c = cathode volume, in milliliters; C = normality of electrolyte; and F = Faraday constant: 96,500 coulombs/mole.

The separation coefficient, ε, can be calculated directly from equation (1). The physical significance of ε is that it represents the ratio of the forward velocity of the faster to the slower isotopic ion. The minimum length of column required to obtain a separation of ε is the length of one theoretical unit, h. The over-all separation factor for a column of n theoretical units is given by

$$S_t = \alpha = (N_1/N_2)_c/(N_1/N_2)_a = \varepsilon^n \qquad (2)$$

where c and a refer to the cathode and anode compartments.

[1] A statement describing briefly the method and some early experimental results of isotope separation was submitted to the director of the National Bureau of Standards on 13 June 1941. Until recently it has been withheld from publication because of wartime security restrictions.

[2] At present with the U. S. Navy Department.

A lower limit for h can be computed for a capillary tube and can be approximated for a packing by assuming that the pores behave as equivalent capillaries. In the ideal case of a capillary with isothermal cross-section, h is limited by the fact that the liquid velocity profile is parabolic while the ion velocity profile is

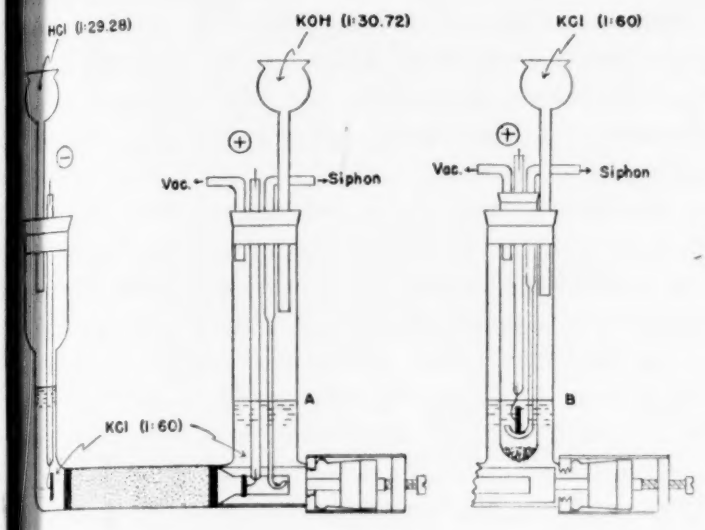

FIG. 1

uniform; it is also limited by back diffusion. The relationship is expressed by

$$h = (1/48)\ V_a r^2_o/D + D/V_a \text{ cm.} \qquad (3)$$

where V_a = mean liquid velocity, in centimeters/second; r_o = radius of bore, in centimeters; and D = coefficient of stagnant diffusion, in square centimeters/second.

Equation (3) shows that approximately 100 theoretical units per centimeter should be obtained in a 100-mesh granular packing. This cannot be realized in practice, however, because of remixing due to nonuniformity of pore size, temperature variation, convection, and inconstancies in operating conditions.

One of the many types of cells tested is illustrated in Fig. 1.

The results obtained in a typical run are given in Table 1. In this experiment a 100-mesh sand packing, 10 cm. in length and 1.4 cm. in diameter was used. The anode compartment was of the B type, which is to be preferred since it does not necessitate precise metering of the solution of potassium chloride. A solution of hydrochloric acid was admitted to the cathode compartment at such a rate that the solution turned from acid to alkaline midway between drops, the rate of feed being controlled by manually adjusted capillary droppers. The cathode volume was 11 ml., and the electrolysis current was 0.5 amp. with a potential drop between the electrodes of 93 volts. The abundance ratios, $^{39}K/^{41}K$, were measured with a mass spectrometer by the method previously described (*1*).

TABLE 1

Hours	$^{39}K/^{41}K$	
0	14.20	(Natural potassium)
41	15.30	
131	16.4	
161	18.2	
209	19.2	
281	20.5	
329	21.1	
377	22.2	
449	24.0	

A large number of experiments have been performed to determine the separation efficiency under various conditions. The maximum value observed for ε is 1.0039, while the average value is 1.0022. Changes of more than 50 per cent in the relative concentration of ^{39}K or ^{41}K have been obtained.

References

1. BREWER, A. KEITH. *J. Amer. chem. Soc.*, 1936, **58**, 370; *Ind. eng. Chem.*, 1938, **30**, 893.
2. KENDALL, JAMES. *Science*, 1928, **67**, 163.
3. LINDEMANN, F. A. *Proc. roy. Soc.*, 1921, **99A**, 103.
4. TISELIUS, A. *Trans. Faraday Soc.*, 1937, **33**, 524.

Determination of Total Body Water and Solids With Isotopes[1]

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Measurement of total body water has in the past been accomplished on post-mortem material by desiccation techniques (*12*). In animals it has been possible to measure total body water by the dilution of urea or sulfanilamide (*10*), but neither of these methods is particularly well adapted to such measurements in the human patient. The ideal method with which to measure a body fluid compartment is by the dilution of a "tracer" for one of the normal constituents of that compartment. For the measurement of total body water the theoretically ideal tracer would be an isotope of hydrogen or oxygen.

In the past, techniques for the measurement of other body fluid compartments have been developed. Most of these methods depend, in one form or another, on the tracer principle and the basic formula:

$$V_2 = \frac{C_1\ V_1}{C_2}$$

where C_1 and V_1 represent, respectively, the concentration and volume of the tracer before dilution in the subject, and C_2 and V_2, concentration and volume after injection. Such methods have yielded measurements of plasma volume (*3*), red cell volume

[1] The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and Harvard University.

(*5, 6, 11*), thiocyanate space (*4*), and radiosodium space (*7*) which can be carried out in the living organism. These techniques have been used extensively in this laboratory, and in addition the measurement of the extracellular space with radiochloride and radiobromide has been investigated.

Extending these observations further, experiments

TABLE 1

TOTAL BODY WATER OF RABBITS

Exp.	Live weight	Total body water Direct (grams or cc.)	Total body water D_2O space (grams or cc.)	Total body water Direct (% body weight)	Total body water D_2O space (% body weight)	Deviation
1	2,888.0	2,095.5	1,950.0	72.5	67.6	−4.9
2	862.5	630.5	626.0	73.1	72.6	−0.5
3	1,128.0	825.0	806.0	73.1	71.6	−1.5
4	753.5	542.9	558.0	72.0	75.4	+3.4
5	910.0	650.0	664.0	71.4	73.0	+1.6
6	1,769.0	1,308.0	1,370.0	73.8	77.4	+3.6
7	1,470.0	1,110.5	1,071.0	75.5	72.9	−2.6
8	1,298.0	983.5	989.0	75.8	76.2	+0.4
9	1,235.8	926.8	846.0	75.0	68.4	−6.6

have been carried out to test the applicability of deuterium oxide to the measurement of total body water. To do this, D_2O was injected into the organism, and samples of serum taken after a short period

TABLE 2

EQUILIBRATION OF D_2O IN HUMAN BEING
(Injection = 100 cc. of 50.0% D_2O)

Time after injection	Serum % D_2O
1 min.	0.139
3 min.	0.135
12 min.	0.088*
30 min.	0.107
1 hr.	0.093
2 hr.	0.093
4 hr.	0.093
19 hr.	0.093

* This low figure at 12 minutes was checked on another gradient.

of mixing and equilibration. The concentration of D_2O in this serum was compared with the concentration of D_2O injected, and by the use of the same fundamental equation, based on dilution, the amount of water in which the D_2O had been mixed was computed. The density measurements to accomplish this have been carried out in a gradient tube patterned after that of Lindstrøm-Lang (*8*) and Lowry (*9*). However, these measurements could also be made by the falling drop method, the mass spectrometer, or a flotation temperature apparatus.

The work of Schoenheimer (*13*) has shown that deuterium exchanges with certain hydrogen atoms of organic compounds in the body. However, both the hydrogen atoms of the water molecule are readily exchangeable with deuterium in the aqueous phase, water constitutes in the neighborhood of 75 per cent of the body weight, and only a fraction of the hydrogen atoms in organic compounds of the body are exchangeable. From calculations based on these facts it is clear that the body-water hydrogen constitutes at least 95 per cent of the total mass of exchangeable hydrogen in the body.

When the total amount of deuterium injected is divided by the concentration found in the serum after an hour, the resultant figure should represent an accurate estimate of total body water. The urinary excretion of deuterium is negligible in the short period of time involved.

To test this hypothesis, measurements of total body water in rabbits have been carried out, and the rabbits then subjected to desiccation using rigorous techniques to rid the carcass of all water. By the weight difference, the total body water in the rabbits has been measured directly. This figure has then been compared with the total body water as measured by deuterium dilution in the same rabbits prior to death. The results of these experiments are shown in Table 1. It is apparent that the deuterium space constitutes a measurement of total body water.

In order to ascertain what interval after injection should be used for determination of the "deuterium space," an experiment was carried out on a human patient (Table 2). After one hour the deuterium concentration in the serum is essentially constant. The one-hour value may, therefore, be used to compute the total body water.

It is hoped that this method will provide physicians and biologists with a means of measurement of total body water for use in experiments on water balance, electrolyte relationships, and metabolism. The extracellular fluid may be subtracted from this figure for total body water to obtain an approximation of the amount of body water to be found within the cell.

The simultaneous measurement of plasma volume with dye, red cell volume with radioactive red cells, extracellular volume with radioactive sodium and with thiocyanate, and total body water with deuterium is technically feasible and can be accomplished in the human patient.

In addition, the total quantity of certain ions present in the patient's body can be determined. By allowing radioactive isotopes of these ions to reach equilibrium in body fluids and tissues and then by dividing the specific activity into the total activity injected, the total weight of ion present in the body can be calculated.

For instance, artificially radioactive potassium[2] may be injected into the patient and the radioactivity

[2] Radioactive isotopes used in this laboratory have been obtained from the Radioactivity Center, Massachusetts Institute of Technology. The author wishes to express his gratitude to Robley D. Evans, John W. Irvine, Jr., and Wendell S. Peacock for their willing cooperation and many helpful suggestions.

total potassium content of the patient's red cells measured until the ratio of activity to total potassium content (specific activity) is constant, indicating that equilibrium has been reached. This specific activity is then divided into the total activity injected, and the total body potassium is thus calculated. In the case of potassium, the urinary excretion even during the course of a few hours is significant and must be measured and subtracted from the injected amount for computation of the total body content.

The question of exchange of artificially radioactive potassium with body potassium and the permeability of red blood cells to radioactive potassium has been studied by Fenn and his co-workers (*1, 2*). By direct analysis of the whole carcass Fenn arrives at a figure of 82.9 mM/kg. as the total body potassium in rabbits. In cats this figure is 77.6, and a value in this range is predicted for the human being. Our results in human beings by the isotope technique have yielded values for total body potassium ranging around 70 mEq/kg.

In our experiments the specific activity of the red cell potassium after intravenous injection of artificially radioactive potassium as potassium chloride in sodium chloride has been used to arrive at the equilibrium value for the ratio $\frac{K^*}{K}$. Such an experiment is shown in Table 3. The urine excretion totals about 6 per cent of the dose in the first 24 hours. Equilibrium was reached at 36 hours in this experiment, and may have been reached sooner in view of the fact that there are no observations between 25 and 36 hours.

By using such a figure for total body potassium in conjunction with the body fluid measurements above, one may calculate the average concentration of intracellular potassium in the patient's body. Before carrying out this calculation, one must subtract from the total potassium present the amount of K in the extracellular space, a figure readily derived by multiplying plasma potassium concentration by the extracellular fluid volume. A correction for the Gibbs-Donnan effect can be introduced in this calculation, but it is probably well within the limits of experimental error.

Similar calculations can be carried out for sodium, using radiosodium as the tracer, and for chloride, using either radiochloride or radiobromide for the tracer. Similar methods could be made practical for other substances (P, S, C), but we have not had experience with the technical problems involved.

A sample isotopic dissection of a normal human being is shown in Table 4.

TABLE 3

RED CELL ACTIVITY AND POTASSIUM SPECIFIC ACTIVITY AFTER INTRAVENOUS INJECTION OF RADIOPOTASSIUM IN THE HUMAN BEING—CALCULATION OF TOTAL BODY POTASSIUM

Hours after injection	K* U/cc. cells	K mg./cc. cells	Specific activity U/mg.
0.5	0.24		0.06
12	2.10		0.54
19	2.62		0.67
25	2.74		0.70
		m = 3.90 ± .17	
36	3.24		0.83
39	3.28		0.84

Calculation of total body potassium:

Total dose K* = 134,250 units total
Urine, 24 hours = 7,294 units total

$$\text{Total body potassium} = \frac{134{,}250 - 7{,}294}{0.835} = 152{,}000 \text{ mg. K}$$

" " " = 3,900 mEq K (weight = 58.5 kg.)
" " " = 66.7 mEq/kg.

TABLE 4

ISOTOPIC MEASUREMENTS IN A NORMAL HUMAN BEING
Subject: D.C.—male, 26 years of age; weight, 66 kg.; height, 181.2 cm.; sitting height, 96.5 cm.

Fluid volumes

Measurement	Cc.	% body weight
Dye plasma volume	2,940	4.45
Dye red cell volume	2,160	3.27
Large vessel hematocrit	42.3%	
Radioactive red cell volume	2,010	3.05
Whole body hematocrit	37.0%	
Radiosodium volume	17,500	26.5
Radiochloride volume	12,500	18.9
Thiocyanate volume	17,850	27.1
Deuterium oxide volume	47,800	72.5
Total body solids (66,000–47,800)	18,200 grams	27.5
Intracellular water (47,800–17,500)	30,300	46.0

Total potassium
Final specific activity of red cell K (18 hours) = 1.005 units/mg.
Total dose of radioactive K = 210,000 units
Urinary radio-K excretion = 13,130 units

$$\text{Total K} = \frac{210{,}000 - 13{,}130}{1.005} = 195{,}800 \text{ mg.} = 5{,}030 \text{ mEq} = 76.2 \text{ mEq/kg.}$$

Average intracellular K concentration
Serum K = 5.4 mEq/L
Extracellular K = 5.4 × 17.5 = 94.5 mEq
Intracellular K = 5,030 − 94.5 = 4,935.5 mEq

$$\text{Average intracellular K concentration} = \frac{4{,}935.5}{30.3} = 162.7 \text{ mEq/L}$$

Total sodium
Final specific activity of plasma Na = 87.3 units/mEq (20 hrs.)
Total dose of radioactive Na = 340,000 units

$$\text{Total Na} = \frac{340{,}000}{87.3} = 3{,}890 \text{ mEq}$$

Average "intracellular" Na concentration
Extracellular Na = 17.5 × 140 = 2,450 mEq
"Intracellular" Na = 3,890 − 2,450 = 1,450 mEq

$$\text{"Intracellular" Na concentration} = \frac{1{,}450}{30.3} = 47.8 \text{ mEq/L}$$

This figure for "intracellular" Na includes bone matrix sodium and is an average of all the Na not in solution in extracellular fluid. It should not be construed as indicating the Na concentration in, for example, muscle or liver cells. However, it will vary if these latter concentrations are altered.

The application of these methods to a wide variety of metabolic problems may provide information otherwise not available on living human patients and formerly only obtainable in animals by analysis of the carcass.

References

1. DEAN, R. B., NOONAN, T. R., HAEGE, L., and FENN, W. O. *J. gen. Physiol.*, 1941, **24**, 353.
2. FENN, W. O., NOONAN, T. R., MULLINS, L. J., and HAEGE, L. *Amer. J. Physiol.*, 1941, **135**, 149.
3. GIBSON, J. G., II, and EVANS, W. A., JR. *J. clin. Invest.*, 1937, **16**, 301.
4. GREGERSON, M. I., and STEWART, J. D. *Amer. J. Physiol.*, 1939, **125**, 142.

5. HAHN, P. F., ROSS, J. F., BALE, W. F., BALFOUR, W. M., and WHIPPLE, G. H. *J. exp. Med.*, 1942, **75**, 221.
6. HOPPER, J., JR., TABOR, H., and WINKLER, A. W. *J. clin. Invest.*, 1944, **23**, 628.
7. KALTREIDER, N. L., MENEELY, G. R., ALLEN, J. R., and BALE, W. F. *J. exp. Med.*, 1941, **74**, 569.
8. LINDSTRØM-LANG, K., and LANZ, H., JR. *C. R. Trav. Lab. Carlsberg*, 1935–38, **21**, 315. (Série chemique.)
9. LOWRY, O. H., and HUNTER, T. H. *J. biol. Chem.*, 1945, **159**, 465.
10. PAINTER, E. E. *Amer. J. Physiol.*, 1940, **129**, 744.
11. PEACOCK, W. C., EVANS, R. D., IRVINE, J. W., JR., GOOD, W. M., KIP, A. F., WEISS, S., and GIBSON, J. G., II. *J. clin. Invest.*, in press.
12 PFEIFFER, L. *Z. Biol.*, 1886–87, **23**, 340.
13. SCHOENHEIMER, R. *The dynamic state of body constituents.* (Harvard Univ. Monogr. in Medicine and Public Health, No. 3.) Cambridge, Mass.: Harvard Univ. Press, 1942.

The Growth Response of *Tetrahymena geleii* W to Folic Acid and to the *Streptococcus lactis* R Factor

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It has been shown (*3*) that *Tetrahymena geleii* W requires folic acid for growth.[1] The growth response was found to be linear to additions of a folic acid concentrate (potency: 5,000) up to 0.02 γ/ml. of medium. When calculated on the basis of 40,000 potency a concentration of 0.002 γ/ml. of medium gave half maximum growth.

Recently we have tested three crystalline preparations for their growth-promoting activity on *T. geleii* W: (1) Lederle Folic Acid;[2] (2) Parke Davis Vitamin Bc;[3] and *Streptococcus lactis* R (SLR) Factor.[4] The ciliates were tested in the supplemented amino acid medium which had been used for the work on the folic acid concentrate (*3*). The quantitative results are expressed as the number of organisms per milliliter in the third serial transplant after 72 hours of incubation at 25° C.

The Lederle crystals and the Parke Davis crystals (Bc) have almost identical growth-promoting activity, as can be seen from Fig. 1. Linear growth responses occur between concentrations of 0.075 and 1.0 millimicrograms/ml. of medium. Concentrations lower than 0.075 millimicrograms/ml. are nearly inactive. The growth-promoting activity of SLR factor for *T. geleii* W is extremely low, however. Approximately half maximum growth was obtained with a concentration of 360 millimicrograms/ml. of medium (the highest concentration used was 540 millimicrograms/ml., and this amount proved toxic), and concentrations lower than 150 millimicrograms/ml. were entirely inactive.

These results show that *T. geleii* W, a microorganism of animal nature as judged by its amino acid requirements (*4, 5*), is similar to *Lactobacillus casei* in its response to the "folic acids" and to SLR factor. They are significant in the light of the findings of Hutchings, *et al.* (*1*) that the antianemia activity for chicks of the various folic acids corresponds to *L. casei* rather than *Str. lactis* R activity. Table 1 summarizes the activity of the various factors for *T. geleii* W as compared with *L. casei* and *Str. lactis* R. When the activity of the folic acid concentrate which was previously used (*3*) (Texas preparation) is calculated on the basis of 137,000 potency[5] there is close

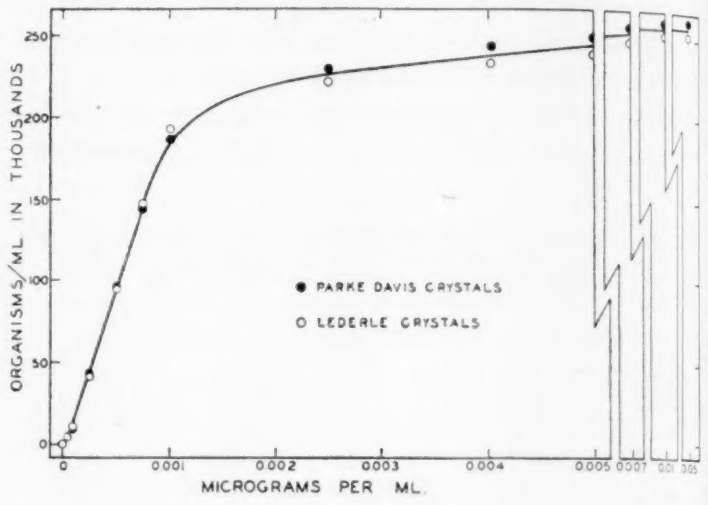

FIG. 1

TABLE 1

Material	Organism	Amount for half maximum activity	Investigator
		γ/ml.	
Texas preparation	*L. casei*	0.000072	Snell (*8*)
	Str. lactis R	0.000055	Mitchell and Snell (*6*)
	T. geleii W	0.00058	Kidder (*3*)
Lederle crystals	*L. casei*	0.000055	Stokstad (*9*)
	Str. lactis R	0.00025	Stokstad (*9*)
	T. geleii W	0.00065	Kidder and Fuller
Parke Davis crystals (vitamin Bc)	*L. casei*	0.00005	Pfiffner, *et al.* (*7*)
	Str. lactis R	0.00025	Hutchings, *et al.* (*1*)
	T. geleii W	0.00065	Kidder and Fuller
Merck crystals (SLR factor)	*L. casei*	Not active	Keresztesy, *et al.* (*2*)
	Str. lactis	0.000034	Keresztesy, *et al.* (*2*)
	T. geleii W	0.36	Kidder and Fuller

[1] The folic acid used was a concentrate having a potency of 5,000 and was obtained from R. J. Williams.
[2] Furnished through the courtesy of S. M. Hardy and Lederle Laboratories (control No. 7–5582).
[3] Furnished through the courtesy of O. D. Bird and Parke Davis and Company (control No. 90905).
[4] Furnished through the courtesy of J. C. Woodruff and Merck and Company (control No. 5R1336).
[5] Folic acid concentrate. The calculations are based on potency 137,000 (see H. K. Mitchell, E. E. Snell, and R. J. Williams, *J. Amer. chem. Soc.*, 1944, **66**, 267).

agreement between it and the activities reported here. In all three cases of high activity, half maximum growth of *T. geleii* W was obtained with approximately 10 times the concentrations necessary for *L. casei*. These figures should be useful in comparing the folic acid requirements of other animals when methods can be devised for precise testing.

References

1. HUTCHINGS, B. L., STOKSTAD, E. L. R., BOHONOS, N., and SLOBODKIN, N. H. *Science*, 1944, **99**, 371.
2. KERESZTESY, B. C., RICKES, E. L., and STOKES, J. L. *Science*, 1943, **97**, 465.
3. KIDDER, G. W. *Arch. Biochem.*, 1946, **9**, 51.
4. KIDDER, G. W., and DEWEY, V. C. *Arch. Biochem*, 1945, **6**, 425.
5. KIDDER, G. W., and DEWEY, V. C. *Physiol. Zool.*, 1945, **18**, 136.
6. MITCHELL, H. K., and SNELL, E. E. *Univ. Texas Publ.*, 1941, **4137**, 36.
7. PFIFFNER, J. J., BINKLEY, S. B., BLOOM, E. S., BROWN, R. A., BIRD, O. D., EMMETT, A. D., HOGAN, A. G., and O'DELL, B. L. *Science*, 1943, **97**, 404.
8. SNELL, E. E. *Proc. Soc. exp. Biol. Med.*, 1944, **55**, 36.
9. STOKSTAD, E. L. R. *J. biol. Chem.*, 1943, **149**, 573.

News and Notes

Support for S. 1850

Senator Magnuson has assured *Science* that he is ready to try again in the next session of Congress, to secure the passage of a bill providing for a National Science Foundation. He regretted the failure of the Kilgore-Magnuson Bill, S. 1850, in the House Committee which killed it, although it had been passed by the Senate.

Senator Magnuson said that he could speak for the continued cooperation of his colleague, Senator Kilgore, who was at the time, 2 August, absent from Washington in the interest of his renomination, which was subsequently achieved in the West Virginia primary.

Senator Magnuson's original bill was based on the Bush Report and it differed in several important details from Senator Kilgore's Bill, but the differences were adjusted in a series of conferences as previously related in *Science*.

About People

Ruth R. Puffer, director of statistical service, Tennessee Department of Public Health, has been appointed visiting professor in the School of Public Health, University of Chile, for the term, June–August 1946. In addition to her duties in connection with the University, she is a consultant on statistical and tuberculosis work for Chile. Dr. Puffer's visit is being sponsored by the Rockefeller Foundation, which has been instrumental in the establishment of the School of Public Health and a training program for public health specialists for Chile.

Eugene Fischer, professor of physical anthropology, University of Berlin, and director of the Kaiser Wilhelm-Institut für Physische Anthropologie, Menschliche Erblehre und Eugenik, is completing an extensive work, *Comparative human morphology.* Dr. Fischer was pensioned in 1942 and has lived in Sontra Bebra, Province of Hessen-Nassau, since 1944, when he was bombed out in Freiburg.—***Bruno Oetteking*** (Museum of the American Indian, Heye Foundation, New York City).

James F. Kerwin and *James W. Wilson* have been added to the staff of the Division of Organic Chemistry at Smith, Kline and French Laboratories, Philadelphia.

Kenneth C. Blanchard, special investigator, Survey of Antimalarial Drugs, spoke on "Chemotherapy of Malaria" before a meeting of the Virginia Chapter of Sigma Xi on 13 May. Eight members and nine associates were initiated on the same occasion.

F. Woodbridge Constant, associate professor of physics at Duke University, will become head of the Department of Physics at Trinity College this fall, succeeding Henry A. Perkins, who has taught at the College for the past 42 years.

M. M. Leighton, chief of the Illinois State Geological Survey, addressed the staffs and graduate students of the Departments of Geology at Harvard University on 22 April, at Columbia University on 25 April, and at Yale University on 26 April. His subject was: "The Operation of a Modern State Geological Survey."

David Shakow has been appointed chief psychologist in the Psychiatric Division, Illinois Neuropsychiatric Institute, and professor in the Department of Psychiatry, University of Illinois College of Medicine. Dr. Shakow has been chief psychologist at the State Hospital, Worcester, Massachusetts, for 18 years. He will assume his new duties on 1 September.

George E. Cottral has returned to the U. S. Regional Poultry Research Laboratory, East Lansing, Michigan, as pathologist after serving in the Veterinary Corps, U. S. Army, for four years. As liaison veterinarian he accompanied a unit of the Chinese 38th Division to the Burma front. Later he went over the Hump to China to become liaison veterinarian for the Chinese 71st Army on the Salween front.

Aaron J. Sharp has returned to his duties at the Department of Botany, University of Tennessee, after two years study on a Guggenheim Fellowship in Mexico and Guatemala.

Reuben G. Gustavson, biochemist, vice-president and dean of the faculties at the University of Chicago since 1945, became chancellor of the University of Nebraska, Lincoln, effective 1 August. He succeeded Chancellor C. S. Boucher, who retired because of ill health.

Fred R. Cagle, formerly director of the Museum and assistant professor of zoology at the Southern Illinois Normal University, Carbondale, has been appointed associate professor of zoology at Tulane University.

Lt. Col. Carl E. Otto will return to his position as associate professor of chemistry at the University of Maine after six years of active duty in the Chemical Warfare Service.

Arnold B. Grobman, formerly instructor in zoology at the University of Rochester and at present associated with the Manhattan District (U. S. Army Corps of Engineers) at the University of Rochester Medical School, will join the staff of the University of Florida this fall as assistant professor of biology.

Frank Perlmutter, formerly with the U. S. Department of Agriculture, Soil Conservation Service, has been appointed associate horticulturist at the New York Branch Office of the Veterans Administration.

Harry Burrell and *C. P. Neidig,* both formerly associated with the Heyden Chemical Corporation, have announced the formation of Burrell & Neidig, Inc., an industrial chemical consulting firm with offices at 115 Broadway, New York City. The firm plans to consult on formaldehyde and its uses, plastics and their raw materials, protective coatings, sales development work on new products, research administration, and market surveys for the chemical and allied fields.

H. M. Pendlebury, former director of the Selanger Museum at Kuala Lumpur, Federated Malay States, died in Bangalore, India, in October 1945, according to a letter from Bachik bin Mohd Tahir, caretaker of the Museum. Dr. Pendlebury's death was a result of ill-treatment by the Japanese during his three and a half years internment in Singapore.

The letter also stated that the museum had been destroyed by bombing in March 1945.—*W. D. Funkhouser* (University of Kentucky).

Henry M. Fox has been appointed assistant professor of psychiatry at the Harvard Medical School and senior associate in psychiatry at the Peter Bent Brigham Hospital, directing a program coordinating the teaching of psychiatry and internal medicine under a grant from the Commonwealth Fond. Dr. Fox was formerly associated with The Johns Hopkins University and Hospital and recently returned from service in the Army Medical Corps.

Kenneth G. Brill, head of the Department of Geology, University of Chattanooga, has been appointed assistant professor in the Department of Geology at Saint Louis University, of which Victor T. Allen is director. Dr. Brill will teach paleontology and stratigraphy in the Institute of Geophysical Technology.

J. N. Mrgudich, associate chief engineer, Burgess Battery Company, Freeport, Illinois, for five and one-half years, has become senior chemist and chief of electron microscopy in the Micro Optical Section, Components and Materials Branch, Squier Signal Laboratory, Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey.

Announcements

The Social Science Research Council, aided by a grant from the Rockefeller Foundation, has undertaken to place gift sets of American social science books and monographs published since 1939 in 40 university libraries in European countries occupied by Germany during the war. The basic collection of 2[illegible] books which is being sent to each recipient library is valued at over $1,000 and includes books from the fields of anthropology, demography, economics, history, political science, social psychology, sociology, and statistics. These books were chosen from lists of the outstanding works produced during the last eight years in the designated fields. Library authorities have been invited to choose additional volumes in accordance with their special needs, however, in order to achieve a balanced minimum collection of American social science materials issued during the war as well as a specialized collection adapted to the institution's own particular program.

The project is under the direction of Thorsten Sellin, professor of sociology and chairman of the Department, University of Pennsylvania. Dr. Sellin is also the editor of *The Annals of the American Academy of Political and Social Science.*

The first postwar meeting of the Pacific Division AAAS, and the first meeting of the Division to be held since 1942, was held at the University of Nevada, Reno, 17–22 June 1946, with 305 registered members and guests in attendance. This represented the 27th annual meeting of the Pacific Division, and was the second meeting of the Division to be held in Reno.

The general sessions began on the morning of 18 June with a symposium on "Antibiosis," presenting the results of recent research in this field. Thomas L. Jacobs discussed "Antimalarials," David Bonner spoke on "Chemical and Biological Aspects of Penicillin," K. Stephen Pilcher discussed "The Large-scale Production of Penicillin," and Lowell A. Rantz presented a comprehensive summary of "Antibiotics in Medicine."

On Tuesday afternoon President and Mrs. John O. Moseley received the members and guests of the Division and associated societies in the new gymnasium on the University of Nevada campus.

On Tuesday evening Holbrook Working presented the first evening address, on "Research in the Social Sciences," drawing thought-provoking comparisons between methods in the natural and the social sciences and pointing out that many phases of contemporary history are in fact large-scale social experiments.

The presidential address of Linus Pauling, retiring president of the Pacific Division, was given Wednesday evening, on the subject, "The Influence of Molecular Structure on Biological Activity." At the conclusion of his address Prof. Pauling was given an ovation seldom accorded a scientist speaking on a technical subject.

The concluding address on Thursday evening was given by Wendell M. Latimer, who spoke on "Fundamental Particles and Atomic Energy." After a lucid exposition of the present status of our knowledge of the atom, Prof. Latimer expressed an optimistic view of the probability of early and important applications of atomic energy to peacetime uses.

Thomas G. Thompson, director of the Oceanographic Laboratories, University of Washington, was elected to the presidency of the Division, succeeding Prof. Pauling. H. S. Reed was elected vice-president and chairman of the Executive Committee. Vern O. Knudsen and Carl L. Hubbs were elected members of the Executive Committee for five-year terms, and George R. Hill and G. W. Sears were elected members-at-large of the Council for four-year terms.

Resolutions were adopted supporting the National Science Foundation Bill (S. 1850), specifically advocating inclusion of the social sciences, and supporting the McMahon Bill for control of atomic energy by a purely civilian board. These resolutions were telegraphed to the appropriate members of Congress.

The following societies, meeting in conjunction with the Pacific Division, held programs for the reading of scientific papers: American Chemical Society (Pacific Intersectional Division), American Meteorological Society, American Society for Horticultural Science (Western Section), American Society of Plant Physiologists (Western Section), American Society of Ichthyologists and Herpetologists (Western Division), Astronomical Society of the Pacific, Botanical Society of America (Pacific Division), California Academy of Sciences, Ecological Society of America (Western Division), Society of American Bacteriologists (Southern California Branch), Society for Experimental Biology and Medicine (Pacific Coast Branch), Western Society of Naturalists, and Western Society of Soil Science.—*Robert C. Miller* (Secretary, Pacific Division, AAAS.)

The Arctic Institute of North America announces two fellowships of up to $2,000 each (Canadian currency) for scientific work in the Canadian Arctic or Subarctic during 1947. The fellowships are open to anyone who has demonstrated his ability to carry out research work of superior quality in some field of science.

Applications must be received by 1 November 1946. Fellowships will be awarded on the recommendation of the Board of Governors of the Arctic Institute and will be announced by February 1947. Application forms may be obtained from: The Arctic Institute of North America, 805 Sherbrooke Street West, Montreal, Canada.

The 1946 fellowships of $1,500 each were awarded to Margaret Lantis, Washington, D. C., for ethnologic study of the Eskimos on Nunivak Island, Alaska, and to Harold C. Hanson, Illinois State Natural History Survey, for wildlife research on the west coast of James Bay, northern Ontario. An additional grant of up to $1,500 was made to Nicholas Polunin, Oxford University, England, for botanical work on Ungava Peninsula.

A fellowship in the field of microbiology has been announced by the Graduate School of the University of Pennsylvania. The fellowship, which has been established by the Pennsylvania Lager Beer Brewers' Association, carries a stipend of $1,500. Applicants must have had at least one year of graduate work and must have a sight-reading knowledge of two modern languages. Inquiry should be made at the Graduate School, University of Pennsylvania, Philadelphia.

The trustees of the Worcester Foundation for Experimental Biology elected the following new trustees at their annual meeting: David Rapport, M.D., professor of physiology, Tufts Medical School; George R. Dunlop, M.D., of Worcester; Richard Perkin, president of the Perkin-Elmer Corporation, Glen-

brook, Connecticut; and Robert W. Stoddard, president of the Wyman Gordon Products Company, Grafton, Massachusetts, and vice-president of the Wyman Gordon Company, Worcester.

All the officers of the Foundation were re-elected as follows: Harlow Shapley, Ph.D., president of the Board of Trustees; Roy G. Hoskins, Ph.D., secretary; Dwight E. Priest, treasurer; J. Z. Buckley, assistant treasurer; Hudson Hoagland, Ph.D., executive director, and Gregory Pincus, Ph.D., director of laboratories.

During 1946 the Foundation is operating on grants from the following institutions: the American Cancer Society; the Donner Foundation; the G. D. Searle Company, Chicago; the Schering Corporation, Bloomfield, New Jersey; the Foundation for Applied Research, San Antonio, Texas; the National Research Council; the U. S. Navy; the American Academy of Arts and Sciences; the American Philosophical Society; the Neuroendocrine Research Foundation of the Harvard Medical School; the Massachusetts Department of Mental Health; and the Committee on Therapeutic Research of the Council of Pharmacy and Chemistry of the American Medical Association.

Studies are under way in relation to animal reproduction, the physiology and biochemistry of cancer, the chemistry of steroid hormones, the physiology and biochemistry of mental disease, and chemical factors involved in the invasiveness of bacteria and in biochemical aspects of fatigue. Clinical facilities at the Worcester State Hospital, the Worcester City Hospital, and the Massachusetts General Hospital are available for these investigations.

The appointment of three section chiefs in the Metrology Division, formerly the Division of Weights and Measures, the National Bureau of Standards, was announced recently by E. U. Condon. I. C. Schoenover was designated chief of the Dental Materials Section, Peter Hidnert, of the Thermal Expansion Section, and H. Haig Russell, of the Large-capacity Scales Section.

Meetings

The American Chemical Society will hold its fall meeting in Chicago on 9–13 September. At the same time 18 divisions of the Society will meet. The Chicago Section of the Society will sponsor the Fourth National Chemical Exposition from 10–14 September.

The American Psychological Association will hold its 54th annual meeting at the University of Pennsylvania, Philadelphia, on 3–7 September. A new feature of the meeting will be an Invited Address, to be given this year by A. C. Kinsey, University of Indiana, on "Studies on Human Sex Behavior" on the evening of 4 September.

The Ninth Meeting of the Society for Research on Meteorites, the first since the close of the war, will be held on 9 September at Arizona State College, Flagstaff, and on 10 September at the Canyon Diablo Meteorite Crater. The opening session will take place at 9:00 A.M. on 9 September. Any person interested in meteorites is cordially invited to attend the meeting, all sessions of which, except those of the Council, will be open to the public. C. H. Cleminshaw, Griffith Observatory, P. O. Box 9866, Los Feliz Station, Los Angeles 27, California, is secretary of the Society.

The American Physical Society will hold its 274th meeting on 19–21 September at the Engineering Societies Building, 29 West 39th Street, New York City, under joint sponsorship with the American Society of Mechanical Engineers, the Metropolitan Section of the American Physical Society, and the Metropolitan Section of the American Society of Mechanical Engineers. The program will consist of papers and discussions on accelerators, cosmic ray and subnucleonic physics, and theories of the elementary particles.

The meeting has been planned to take advantage of the presence in the East of a number of distinguished physicists from abroad and from home who are being invited to take part in a conference to be held shortly afterward as a feature of the bicentennial celebration of Princeton University.

The Biological Photographic Association will hold its 16th annual meeting at the Hotel Bismarck, Chicago, on 6–8 September. The planning and production of teaching motion-picture films will be discussed. New equipment for both still and motion picture photography will be demonstrated. Discussions will be held on the preparation of scientific exhibits; the classification, indexing, and filing of medical illustrative material; and the Veterans Administration's program for obtaining medical illustration material will be described. Practical papers on fundamental techniques will be presented, as well as more specialized work on endoscopic photography, photomicrography, etc. Photographs by many of the leading biological photographers and new materials and equipment will be on display. Jay Garner, of Winnetka, Illinois, is convention chairman, and Ralph Creer, of the Motion Picture Committee, American Medical Association, is in charge of the program.

The Biological Photographic Association, a non-profit organization, was formed in 1931 to raise the standards in photography for teaching and research and to act as a clearing house for information

photographic methods. Its members are scientists with an interest in photography as applied to their fields and designers of precision equipment. The Association's journal is published quarterly constituting a volume of about 250 pages. Further information about the Association may be obtained by writing the Secretary of the Biological Photographic Association, University Office, Magee Hospital, Pittsburgh 13, Pennsylvania.

"The Chemical Trail Blazers," a display epitomizing new discoveries, ideas, developments, and applications in industrial chemistry, will be featured at the Fourth National Chemical Exposition to be held on 10–14 September at the Coliseum, Chicago. The exhibit, sponsored by the Chicago Section, American Chemical Society, and under the chairmanship of James K. Stewart, will be a major development of a comparatively small collection of sketches, panels, and specimens shown under the same title at the last National Chemical Show in the same building in 1944. It will be presented on a more elaborate, more comprehensive, and broader scale this year and will occupy more space. The following will be a few of the featured exhibits: The heredity factor in red hair; some diverse products made from shavings; an extremely light form of rubber; the utilization of waste from such diverse materials as oat hulls and sulfite liquor; the sources of rare chemicals; paint as a protective agent against rust; and the power of color.

The Cordoba Observatory, Cordoba, Argentina, is celebrating the 75th anniversary of its foundation with a scientific meeting to be held on 20–23 September.

The American Ornithologists' Union will hold its first annual meeting since 1942 on 2–5 September in Urbana and Champaign, Illinois. This will be a regular meeting with the presentation of papers, a banquet, social gatherings, and field trips. Headquarters will be in the new Illini Union Building, of the University of Illinois, where the business meetings will be held on Monday, 2 September. The meeting is sponsored by the Department of Zoology and Physiology, University of Illinois; the Illinois Natural History Survey; and the Champaign County Audubon Club. The chairman of the Local Committee on Arrangements is S. Charles Kendeigh, Vivarium Building, Wright and Healey Streets, Champaign, Illinois.

Reservations for rooms should be made immediately at either the Inman Hotel, Champaign, or the Urbana-Lincoln Hotel, Urbana. Rooms in private homes will be found for guests who cannot be accommodated by the hotels.

The Division of Sugar Chemistry and Technology is planning as part of its program for the Chicago meeting of the American Chemical Society, 9–13 September, a celebration in honor of C. S. Hudson, of the National Institute of Health. The opening session will include the following papers covering Prof. Hudson's contributions to the field of carbohydrate chemistry: "An Historical Review of the Contributions of the Hudson School to Carbohydrate Chemistry": R. C. Hockett, Sugar Research Foundation; "Reflections on the Hudson Contributions on Academic Carbohydrate Researches": C. B. Purves, McGill University; and "The Influence of Hudson's Fundamental Research on Industrial Carbohydrate Chemistry": W. W. Moyer, A. E. Staley Manufacturing Company. An address by Prof. Hudson will follow.

Another feature of the program is a symposium on "Current Progress in Carbohydrate Chemistry." W. N. Haworth, University of Birmingham (England), and G. F. Davidson, Shirley Institute at Manchester (England), will present papers at the symposium.

The celebration will be climaxed by a banquet in honor of Dr. Hudson. K. P. Link, University of Wisconsin, will act as master of ceremonies, and H. O. L. Fischer, University of Toronto, will be the main speaker. A special event will be the presentation of the *Collected works of C. S. Hudson* to Dr. Hudson by a representative of the editorial division of the Sugar Division. This collection, a two-volume edition being published by the Academic Press, includes all the papers which have been published by Dr. Hudson and his associates. Two of his present associates, R. W. Hann and N. K. Richtmeyer, National Institute of Health, have acted as editors.

The American Mathematical Society announces its 52nd Summer Meeting and 28th Colloquium, to be held at Cornell University, Ithaca, New York, on 20–23 August, in conjunction with the summer meetings of the Mathematical Association of America and the Institute of Mathematical Statistics. The program follows:

Tuesday, 8:00 P. M.—Council meeting; *Wednesday,* 10:45 A. M.—"General Principles of Functional Representation": Marshall Stone, Harvard University; *Thursday,* 2:00 P. M.—"Probability in Function Space": J. L. Doob, University of Illinois.

The Colloquium will consist of four lectures on "Topology of Smooth Manifolds," by Hassler Whitney, Harvard University. These are scheduled for Tuesday at 2:00 P. M., and Wednesday, Thursday, and Friday at 9:00 A. M.

Balch and Risley dormitories, Cornell University, will be available to members of the mathematical organizations, their families, and guests. Reservation

cards for dormitory rooms will be sent out with the program. Hotel reservations should be made directly with the Clinton and Ithaca Hotels.

Recent Deaths

Edward Godfrey Huber, 64, associate dean, Harvard University School of Public Health, died in Boston on 24 July. Dr. Huber had been acting dean of the School since 1942 and was named associate dean only a short time ago.

A. W. Rogers, 74, formerly director of the South African Geological Survey, died on 23 June at Capetown.

George Alfred Olson, 71, formerly of the Agricultural Experiment Station, University of Wisconsin, died on 29 July at Madison.

Clement Samuel Brimley, 82, entomologist, North Carolina Department of Agriculture, died on 23 July in Raleigh.

Arturo Posnansky, 72, leading Bolivian archeologist of old Inca ruins, died on 28 July at La Paz, Bolivia.

Rolf Nugent, 44, economist and deputy chief of supply for UNRRA, drowned near Yokohama, Japan, on 27 July, according to an announcement by UNRRA. Dr. Nugent was on leave from Russell Sage Foundation and had been in Japan only a few weeks.

Cornelius Ubbo Ariens Kappers, 68, professor of comparative anatomy of the central nervous system at Amsterdam Municipal University, died on 29 July.

Clay B. Freudenberger, 42, former acting dean of the University of Utah Medical School, died on 28 May 1946 in Salt Lake City.

J. L. Baird, 58, well known for his work in the field of television, died on 14 June in England.

Charles C. Haworth, Jr., 31, physicist, died on 28 July as a result of a fall while mountain climbing in the Selkirk Range near Golden, British Columbia. During the war Dr. Haworth worked at The Johns Hopkins Institute of Applied Physics, Silver Spring, Maryland, and since 1 March had been with the Naval Ordnance Test Station, Inyokern, California.

Wilhelm Caspari, 72, head of the Department for Cancer Research at the Institute for Experimental Therapy in Frankfort am Main from 1920 to 1936, died in 1944 in Lodz, Poland.

T. H. Laby, 66, former professor of natural philosophy, University of Melbourne, died recently in Australia.

Herbert Gastineau Earle, 64, director of the Henry Lester Institute of Medical Research, Shanghai, died at sea on 5 June after a stroke. Dr. Earle was formerly professor of physiology and dean of the Medical School at Hongkong University.

Letters to the Editor

History of a Three-color Mixer

The growth of apparatus, like the growth of ideas, is often hindered by the independent rediscovery of what has been done before. Often this is due to the description appearing in an obscure journal, and often the investigators fail to search adequately the more prominent journals.

Recently I found the same color-mixing apparatus described in three separate sources, none of which made any references to the others. The apparatus is a three-color mixer whose colors are mixed by the optical properties of two lenses. This rather ingenious device was filed with the U. S. Patent Office on 4 October 1928 by L. T. Troland (U. S. Pat. 1,971,737). The patent was assigned to the Technicolor Corporation and granted on 28 October 1934. The apparatus was again described in great detail in a manuscript by G. N. Hunter, dated 4 February 1929, which was submitted to the Royal Society of Edinburgh and published shortly thereafter (*Proc. roy. Soc. Edinb.*, 1929, 49, 232–244). The third description, by W. F. Grether, is fairly recent (*Science*, 1943, 98, 248). It too appears in some little detail.

The similarity between these three papers is striking. The methods of placing the filters, the mechanism for moving the filters, the position of the lenses, the position of the light sources, the position of the screens, the method of diffusion, and the general diagrams are almost exactly alike. Here is a remarkable example of similarity of independent invention.

JOZEF COHEN

Cornell University

Social Theory and Social Engineering

The recent article by Bateson (*Science*, 1946, 103, 717) and the reply by Burhoe (*Science*, 1946, 104, 62) raise issues of such importance that some further discussion

seems inevitable. Burhoe believes that the fundamental knowledge of social structure necessary to bring about peace is relatively simple and well known. Bateson feels that this is definitely not true and suspects that the simplicity is an illusion and that until the knowledge is forthcoming the social world is in mortal danger. Considerations of the following kind appear to indicate unequivocally that Bateson is correct:

(1) Naïve inspection of the earth's surface may indicate that large areas are at peace because "each person within them has the same rights and privileges as the others and may obtain what he wants by his own peaceful efforts" (Burhoe). Such inspection of, for example, the whole of Europe also should indicate that large areas have recently been at war and even now are hardly at peace because people have attempted to obtain what they wanted by war and have failed, practically everyone being worse off than before. This has happened twice in less than half a century. On both occasions the result has been essentially the same. There is a good deal of older history suggesting that only a moderate probability should be assigned to the statement that a war is a practical way to achieve economic and material ends. It is not unlikely, moreover, that if colonial or expansionist wars against technologically undeveloped regions are excluded as being (with one important exception) irrelevant to modern conditions, the probability of the thesis being correct is very low indeed. Yet the danger persists or even increases, and the geographical danger spots are still localized in regions where experience might be supposed to indicate the futility of the whole procedure. Clearly there must be other factors involved.

(2) Burhoe's remark, "by his own peaceful efforts," really begs the question and converts his argumbent into a circular one reminiscent of the *virtus dormativa* of Molière—one can have peace by being peaceful. This is to be done by the process of social engineering founded on a theory which is simple and well known but unfortunately not stated. Actually, it is reasonably certain that the values of many communities have included terms which could only be realized in warfare. If what one wants includes victims for human sacrifice, or enemies' heads, or the glory gained by rescuing distressed maidens from wicked men, then one cannot obtain these by one's own *peaceful* efforts. The examples (Aztec, New Guinea, Medieval Europe) are chosen not because they are exotic or picturesque but because they are extreme and therefore easily recognized. Their recognition immediately places on us the duty to ascertain if any of our own wants are of this kind. Moreover, the existence of such wants implies enemies who can be defeated, but if they are too thoroughly defeated, new enemies must be found to maintain the stability of the system of values. Burhoe postulates a world composed of people like himself, Bateson, and the present writer, who want primarily to continue their work peaceably. Unfortunately, there are other sorts of people, and they are not scattered at random but are aggregated into cultural groups. Bateson and the present writer, at least, would probably also consider that certain other specific values have arisen in such non-peaceful cultures which are worth preserving if it can be done without endangering the world.

(3) The factors determining the values of a culture are obviously largely unconscious, or, expressing the matter more operationally, they cannot be changed by a mere logical demonstration of their invalidity. Hence, they give rise to misunderstandings and suspicions which, when reciprocal, tend to grow by mutual stimulation unless there are mechanisms that tend to inhibit their growth. Relative to one group, the other appears unreasonable, unable to see the logical consequences, folly, and immorality of its own actions, and acquires definite psychopathic symptoms. Here we enter very difficult ground precisely because there is *no generally accepted*, inductively verified theory of such phenomena or indeed of the individual psychological phenomena which are integrated to produce the apearance of psychopathic symptoms in the behavior of a group.

(4) We are faced with three alternatives: (a) to wage a colonial expansionist war while we alone have atomic bombs, so gaining the world and losing our own souls; (b) to wait while the inevitable interaction of mutually stimulating suspicions leads through an atomic and bacteriological armaments race to an atomic and bacteriological war, causing unbelievable suffering to millions of people, destroying the material culture of a large part of our own country and of the world and with it much of the intellectual, artistic, and moral heritage dependent on that material culture; or (c) to work to find a way out of the apparent dilemma. The dilemma may prove real, but until this has been unequivocally established, the third alternative is the only one that can appeal to anyone of spirit, intelligence, and decency. If it were as theoretically easy as Burhoe believes, such people would already all be moving, perhaps too slowly, but at least in the same direction. The social engineering comes in when the direction in which we are to go is reasonably well established.

G. Evelyn Hutchinson
Osborn Zoological Laboratory, Yale University

Coordination of Cancer Research

Dr. Hammett's letter (*Science*, 1946, 103, 714) regarding cancer research and especially his suggestion of a large-scale, coordinated research program directed toward practical benefit for the cancer patient are so important that they should not be allowed to be shelved for future consideration.

Our attitude toward the problem of malignancy has been, and continues to be, too complacent. Faced with a problem of such magnitude and complexity, we are inclined to think that its solution must await the chance discovery of some lone worker in the field at some unknown date in the future. In the meantime thousands annually die a lingering death at the hands of this killer.

Actually, this menace should be regarded in the same light as any military foe that might claim the lives of thousands of Americans before their time—that is, the situation should be considered a national emergency. This is no place to await the gradual acquisition of bits

of knowledge by independent groups working on isolated phases of the problem. What is needed here is a well-planned and completely coordinated program, directed by a group of experts in the field and serving to organize the activities of all competent investigators. This program should be financed by a Congressional appropriation of $50,000,000–$100,000,000 annually, a pittance compared to the cost of some of our war projects. It would not even buy a great many heavy bombers. It should be used to support both clinical and laboratory research along every channel considered to be of possible interest directly or indirectly in attaining the goal. There are certainly promising leads to be investigated. Several clinical workers have found sex hormones to have definite suppressive influence on certain types of carcinoma. The new availability of radioactive isotopes opens numerous possibilities to the investigator of the metabolism of malignant tissue. These are only two out of many. If we await their development along the leisurely lines of individual peacetime research, a great deal of time and thousands of lives will be lost.

Dr. Hammett has pointed out the results obtained by a coordinated national research effort in the field of atomic physics. Other examples might be cited where, under the pressure of war necessity and as a result of cooperative effort, results were obtained in one or two years that would normally have required 10 or 15. Typical of these are the development of penicillin, antimalarials, agents for bacteriological warfare, etc. Certainly the need in the cancer problem justifies no less supreme an effort. It may well be true that any practical solution will have to await a chance discovery not yet conceived. The important point is that with a large number of trained investigators working in a coordinated program the opportunity for such a discovery to be made is increased almost proportionally to the number of workers. The statistical likelihood of the lucky accident occurring is greatly enhanced.

Furthermore, it is important that we do not delay. The present program for cancer research should be expanded tenfold, organized and coordinated by a group of our best experts, and financed by government appropriation. The bill recently proposed in Congress along these lines should be supported, if adequate, and action obtained on it without delay.

It is up to the scientists of the country to back such a program and see that it is put into effect. They are in by far the best position to realize what may be accomplished and how little progress is being made at present. The AAAS is the official organization representing the majority of scientists in this country. Is there not some way in which the influence of this organization may be brought to bear to expedite an all-out, large-scale research campaign against public enemy No. 2?

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Human Breast Cancer and the Milk Factor

Dr. Hammett (*Science*, 1946, **103**, 714) appears to favor that women with a history of breast cancer should not nurse their children, this recommendation arising out of the observation that a milk factor or virus has been found to be productive of breast cancer in mice. The following facts and observations should be brought forward to make us cautious in having such advice until our facts with respect to breast cancer in man are better understood:

(1) There is as yet no proof that a baby *exclusively* fed with artificial formulas from the moment of birth on has as good a chance of survival as has a baby which is breast fed—at least, breast fed in the early months of infancy. Experimental evidence shows that a mouse put to the cancerous mother's breast even once will absorb enough of the virus to produce breast cancer later on. Therefore, until such time as we have reliable evidence that the baby raised exclusively on artificial feeding has as good a chance of survival as has the breast fed infant, it is doubtful whether we should run the risk of killing the child in infancy in order to save it from dying of breast cancer in middle age.

(2) Experimental evidence shows that stagnation of milk in the breast plays a role in producing breast cancer in mice. This would seem to be partially substantiated by observations (which should be thoroughly checked) that human breast cancer occurs with undue frequency in women who have not borne children, next most often in women who have borne children but who have not nursed them or have had the nursing period unduly shortened for some reason or other, and least often in women who have nursed successfully a family of offspring. If these observations should prove to be facts, we should be subjecting the mothers of this generation to an increased risk of breast cancer in order to prevent the child of the next generation from having the same condition. Although not exactly a case of robbing Peter to pay Paul, it would be one of inducing cancer in Jennie to save Jane.

(3) Breast cancer in women has its peak incidence around the ages 45 to 50, but many cancers of the breast arise in much older women. This means that such a woman may have had all her children, and they in turn have had all of theirs, before their mother develops her breast cancer. Are we then to urge that these granddaughters should refrain from nursing their children because their grandmother had breast cancer? Were breast cancer so obviously transmitted, we should find a much more frequent familial incidence than we do. Moreover, had the grandmother died a year or two before she developed breast cancer, and hence had she been listed as cancer free, her granddaughters would not have been warned against nursing their offspring, but would have been passing on the virus (if that is the explanation of human breast cancer) nevertheless. This brings us to the statement that I enunciated several years ago, namely, that we cannot breed out cancer, whether it be conditioned by a gene or a virus, unless it be a form of cancer that arises in early childhood before the age of procreation, or unless we stop all the race from breeding or all women from nursing.

(4) If the observations listed in (2) are correct, it is

obvious that the woman who is most likely to develop breast cancer is the woman who is least likely to transmit it; under such circumstances, breast cancer would gradually be eliminated. Such does not seem to be the case.

Finally, let us say that before we make any such radical recommendations as that of urging mothers not to nurse their female children if there is a history of breast cancer in the family, there should be an extensive survey to ascertain facts. An endeavor should be made to trace all women whose mothers died in childbirth or within two hours after, and who can definitely prove that they never were nursed by a wet nurse; and to estimate the percentages, if any, of these who have breast cancer, in order to compare this with those women who have been nursed by their mothers. Due attention must be paid to having comparable age groups in the two classes and to the elimination of those groups in which a possible true heredity of breast cancer from either paternal or maternal side of the family might exist. Should it then be found that women whose mothers so died, and who were not nursed at all, have none or significantly less breast cancer than have women in a comparable group but who were nursed, we may have some data on which to base conclusions. Even then, the late age at which cancer develops will serve as an obstacle in any program of elimination either by not breeding or by not nursing.

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Book Reviews

College mathematics: a general introduction. Charles H. Sisam. New York: Henry Holt, 1946. Pp. xiii + 561. $3.50.

This book might well be subtitled *What every student of mathematics should know.* Beginning with a review of algebra, it includes plane and spherical trigonometry; analytic geometry, both plane and solid; college algebra; and an introduction to some ideas of the calculus. The review is not merely a repetition of a high school course but is presented in adult fashion with amplifications and applications which give the subject fresh interest. Teachers who cannot give class time to algebra will be glad to have in the volume they are using for other subjects the things to which their students so often need to be referred.

Both trigonometry and analytic geometry are compact but complete, covering all the usual theory in fewer than the usual number of pages but with plenty of explanation and exercises. The unusual method developed for the reduction of functions of angles greater than 90° is most economical for that purpose and for later use in connection with the addition formulas. It is interesting to find, in the first paragraph of the chapter on conic sections, pictures of the ellipse, parabola, and hyperbola cut from a right circular cone, with a reference to their historical background in Greek geometry, while after individual treatment of the curves is given their single definition in terms of focus, directrix, and eccentricity. This emphasis on the relationship of the conics is most desirable. With a discussion of tangents and normals comes naturally the basic idea of the differential calculus and its simplest geometric application, maxima and minima. To this, by a judicious mixture of definition and intuition, are added simple indefinite integrals, the definite integral, and area under a curve, making it possible for freshmen to get some notion of a subject whose name has often suggested only mystery. The chapters on the graph of an equation offer the student an opportunity to use all his acquired knowledge in the study of algebraic and transcendental curves, both in rectangular and polar coordinates and in parametric form. This might be an interesting conclusion for a course the emphasis of which has been largely geometric.

There is provision, however, for a more inclusive course as well as for one providing more variety of subject matter. Geometry may continue with a glimpse into three dimensions, dealing with the plane, line, and quadric surfaces in standard form. From the field of college algebra there is a selection of topics, interesting in themselves and valuable for a student who will continue mathematics. In connection with his treatment of probability the author distinguishes between mathematical and empirical probability, making it possible for the student to see applications to subjects from which the use of the classical definition alone would exclude it.

The final chapters, on spherical trigonometry, serve to complete all the material which commonly enters into a first-year course in mathematics. The average class would never cover all of it, though individual gifted students might conceivably gain a bird's-eye view of these fields through its use. Teachers will find here abundant choice for the course fitted to their purposes and will like the logical and direct method of presentation.

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The Cavendish Laboratory. Alexander Wood. Cambridge, Engl.: At the Univ. Press; New York: Macmillan, 1946. Pp. 59. (Illustrated.) $1.00.

This is a brief but stimulating history of the famous Physics Laboratory. The list of Cavendish professors

reads like a *Who's who* of physics during the last century—James Clerk Maxwell; Lord Rayleigh, who, it is interesting to learn, gave his Nobel Prize money to the Laboratory; J. J. Thomson; Ernest Rutherford; and the present professor, Sir Lawrence Bragg. The book contains a good portrait of Rayleigh also one of Maxwell.

A further evaluation of importance of the Laboratory may be made on the basis of the men who have worked there. Included among these are C. T. R. Wilson, W. D. Aston, R. T. Glazebrook, W. N. Shaw, and J. Chadwick.

Peter Kapitza, Russia's leading physicist, for whose research the Mond Laboratory was built, was at the Cavendish for 13 years, eventually holding the Messel Professorship. On a visit to Russia in 1934 he was detained by the Government. His equipment was shipped to Russia so that he could continue his researches.

The book is worth any scholar's time.

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The North American clear-wing moths of the family Aegeriidae. **George Paul Engelhardt. (Smithsonian Institution, U. S. National Museum Bull. 190.) Washington, D. C.: Government Printing Office, 1946. Pp. vi + 222. (Illustrated.) $.75.**

For over 40 years George P. Engelhardt devoted his life to the study of natural history, with special emphasis on entomology. In the latter field he was particularly interested in the Aegeriidae, a distinctive family of moths with clear wings. The present monograph, substantially finished as to species and genera when he died in 1942, has been carried to completion and publication under the auspices of the Smithsonian Institution. It reflects Engelhardt's activity as an unusually able field biologist over four decades and embodies his mature observation of this group during that time. He possessed a rare knowledge of the natural history of the various sections of the United States in detail, and in the course of his many field trips he made numerous friends who cooperated actively in supplying material for study. A reflection of some of these contacts is found among new species he described: *clarkei, dammersi, hennei, richardsi.*

The Aegeriidae have a readily recognizable habitus, although their only diagnostic character is a locking system between the forewings and hindwings, first pointed out by A. Busck in 1909. The larvae are all borers and are easily recognized by the special arrangement of their ocelli and crochets. Several of them are of economic importance, notably as fruit pests.

The monograph divides the family on the basis of adult characters with particular reference to antennae, venation, and male genitalia. Nine groups are set up, which in turn are combined in two main divisions of subfamily rank. The larger of these divisions includes seven groups characterized by a club-shaped antenna with the apex ending in a minute hair tuft. The other two groups, *Bembicia* and *Zenodoxus*, form the smaller main division with antenna tapering toward the apex, without a tuft. A key to the genera includes all except *Palmia* Beutenmüller. However, this genus, which contains only a unique female specimen described by Henry Edwards is retained by the author. Separate keys are provided for the species in a number of individual genera.

New descriptions by the author add 7 genera, 19 species, 4 varieties, 9 races, and 7 forms. With one exception, all the genera shown under Aegeriidae in Dr. McDunnough's *List of the Lepidoptera of Canada and the United States* (Pt. II) are retained. *Parharmonia* Beutenmüller with its two species is merged into *Paranthrene pamima* Beutenmüller, thus combining the three North American species confined in host association to coniferous trees.

The principal genus, *Synanthedon* Hübner, is reduced from 69 species to six species and two subordinate forms. The remainder of this genus is mainly distributed among three restored genera, *Carmenta* Hy. Edwards, *Conopia* Hübner, *Thamnosphecia* Spuler, and a new genus, *Ramosia.* Four of the six other new genera have been created to cover single species each, and two for small groups. Of the 19 new species described, ***Euhagenia hirsuta*** is based on a single male, and ***Carmenta austini*** is described from a male and a female. Most of the others are based on series of some size.

The author, in his discussion of individual species, has contributed a wealth of biological data of great value that adds immensely to the scope and interest of his study. A special index of food plants lists some 30 host plants with which specific aegeriids are associated.

The Smithsonian has included 16 plates in black and white, containing 25 illustrations of wing venation, including the diagnostic wing lock, and 62 drawings of genitalia. Sixteen additional plates, provided through the generosity of the author's family, portray 100 illustrations of adult moths in color. It is particularly helpful that the color plates contain representations of all the new material described with the exception of three new races and one new form. Drawings for 79 of these illustrations were made for the author by Mrs. Mary E. Benson and for the other 21 by Mrs. William Beutenmüller. Reference to the text suggests that the scale of the illustrations of adult moths is about 2×. The scale for the genitalia is not apparent.

Too often the death of a scientist before publication of his lifelong observations robs him of adequate recognition and deprives science of the full fruits of his knowledge. It is fortunate that the Smithsonian Institution, through the National Museum, has undertaken the task of carrying this manuscript through to publication, in conformance with its high standards. Consideration of the adequacy of the taxonomic concepts may be left to the specialists. The comprehensiveness of the basic data speaks for itself, while the detailed biological treatment, the readability in content and form, and the notable provision for illustrations give the work a distinctive character of its own. The Engelhardt monograph will be the authoritative source on the Aegeriidae of North America for a long time.

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